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Geophysical Abstracts 168 January–March 1957

GEOLOGICAL SURVEY BULLETIN 1066-A

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By MARY C. RABBITT, DOROTHY B. VITALIANO, S. T. VESSELOWSKY, *and others*

GEOLOGICAL SURVEY BULLETIN 1066–A

Abstracts of current literature pertaining to the physics of the solid earth and to geophysical exploration

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UNITED STATES DEPARTMENT OF THE INTERIOR

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GEOLOGICAL SURVEY

Thomas B. Nolan, *Director*

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GEOPHYSICAL ABSTRACTS 168, JANUARY–MARCH 1957

By Mary C. Rabbitt, Dorothy B. Vitaliano, S. T. Vesselowsky, and others

INTRODUCTION

EXTENT OF COVERAGE

Geophysical Abstracts includes abstracts of technical papers and books on the physics of the solid earth, the application of physical methods and techniques to geologic problems, and geophysical exploration. The table of contents, which is alphabetically arranged, shows the material covered.

Abstracts are prepared only of material that is believed to be generally available. Ordinarily abstracts are not published of material with limited circulation (such as dissertations, open-file reports, or memoranda) or of other papers presented orally at meetings unless summaries of substantial length are published. Abstracts of papers in Japanese and Chinese are based on abstracts or summaries in a western language accompanying the paper.

LIST OF JOURNALS

Full titles and abbreviations of journals cited for the first time in this issue (with the sponsoring organization and its address where these do not form part of the title) are given below. This list supplements the List of Journals published in Geophysical Abstracts 160 (January–March 1955, Bulletin 1033–A) and the supplements published in Geophysical Abstracts 161–167.

Astrophys. Jour.—Astrophysical Journal. University of Chicago Press.

Bayerische Akad. Wiss. Abh., Math.-Naturw. Kl.—Abhandlungen der Bayerische Akademie der Wissenschaften, Mathematisch-Naturwissenchaftliche Klasse. Munich.

Geol. Survey India Recs.—Records of the Geological Survey of India. Calcutta.

Geol. Survey Nigeria Recs.—Records of the Geological Survey of Nigeria. Lagos, Nigeria.

Indian Acad. Sci. Proc.—Proceedings of the Indian Academy of Sciences. Bangalore.

Kentucky Geol. Survey Bull.—Kentucky Geological Survey Bulletin. University of Kentucky, Lexington.

Mining Geology (Japan)—Mining Geology. Journal of the Society of Mining Geologists of Japan. Tokyo.

Mining Inst. Japan Jour.—Journal of the Mining Institute of Japan. Tokyo.

New Zealand Geographer—New Zealand Geographical Society, Auckland.

Potsdam-Niemegk Geomag. Inst. u. Observatorium Abh.—Abhandlungen des geomagnetischen Instituts und Observatoriums. Meteorologischer und Hydrologischer Dienst der DDR, Berlin.

Rev. Industrie Minérale—Revue de l'Industrie Minérale. Société de l'Industrie Minérale, Paris.

Royal Irish Acad. Proc.—Proceedings of the Royal Academy. Dublin.

FORM OF CITATION

The abbreviations of journal titles used are those adopted by the U. S. Geological Survey and used in many geological journals. For papers in most languages other than English, the title is given in the original language as well as in translation. Slavic names and titles have been transliterated by the system used by the United States Board on Geographic Names. This system of transliteration for Russian was given in Geophysical Abstracts 148 (January–March 1952, Bulletin 991–A). Titles of papers in Japanese and Chinese are given in translation only.

ABSTRACTORS

Abstracts in this issue have been prepared by Beryl T. Everett, Henry Faul, D. R. Mabey, Virginia S. Neuschel, and L. C. Pakiser as well as by the principal authors. The notation "Author's abstract" followed by the initials of an abstractor indicates a translation of the author's abstract.

AGE DETERMINATIONS

168–1. Ahrens, L[ouis] H. Radioactive methods for determining geological age: p. 44–67 *in* Ahrens, L. H., Rankama, Kalervo, and Runcorn, S. K., Physics and chemistry of the earth, v. 1, New York, McGraw-Hill Book Co., 1956.

A review.—*M. C. R.*

168–2. Häntzschel, Walter. Die ältesten Gesteine und Fossilien [The oldest rocks and fossils]: Umschau, Jahrg. 57, Heft 2, p. 52–54, 1957.

A review of recent developments in absolute age determinations on very ancient materials, based mainly on papers by Kulp (Geophys. Abs. 163–129) and Ahrens (Geophys. Abs. 163–130). The ages of lepidolites from Africa, Manitoba, Sweden, and Wyoming, and uraninite and monazite from Karelia, as determined by various methods, are quoted. The indirectly determined ages of algae(?) from Rhodesia and *Corycium* from Finland are also given.—*D. B. V.*

168–3. Elsasser, Walter [M.], Ney, E. P., and Winckler, J. R. Cosmic-ray intensity and geomagnetism: Nature, v. 178, no. 4544, p. 1226–1227, 1956.

Measurements of the remanent magnetism of ancient bricks by E. and O. Thellier suggest that the total intensity of the magnetic field in France decreased by about 65 percent between about A. D. 200 and 1933. If such a decrease were general over the earth's surface and not a local phenomenon, the incident flux of cosmic rays and the rate of production of radiocarbon must have increased during the same period. An equation is derived for the carbon-14 inventory over the earth, assuming that the rate of production of carbon-14 is proportional to the particle flux of cosmic rays over the earth's surface; the minimum effect consistent with the magnetic data is that the ratio of the carbon-14 inventory at t=1933 to that at t=0 is 1.018, corresponding to an error of 240 years in an age of an object 2,000 years old. If the decay in the magnetic field were exponential with the same constant as indicated by Thellier's data, objects 4,000 years old would exhibit a carbon-14 activity too low, corresponding to an age 1,000 years too old.—*M. C. R.*

168–4. Brannon, H. R., Jr., Daughtry, A. C., Perry, D., Simons, L. H., Whitaker, W. W., and Williams, Milton. Humble Oil Company radiocarbon dates I: Science, v. 125, no. 3239, p. 147–150, 1957.

Carbon-14 ages of samples from sites in the lower Mississippi Valley, primarily for archeological information.—*M. C. R.*

168–5. Baumgart, I. L., and Healy, J. Recent volcanicity at Taupo, New Zealand: Pacific Sci. Assoc., 8th Cong., Proc., v. 2, p. 113–127, 1953 (1956).

The soils of the Lake Taupo region in New Zealand include several pumiceous deposits representing sequences of ashfalls erupted from vents east of the lake. Three carbonaceous horizons, representing soils developed during quiescent stages within these sequences, have been dated by the carbon-14 method as 1,700±150,

3,100±200, and 9,000 (tentative) yrs old, respectively. Superficial pumice deposits, not of the ashfall type, probably represent glowing clouds, glowing avalanches, and ashflows, some possibly redeposited by mudflow. These were deposited about A. D. 250 from vents somewhere east of Lake Taupo.—*D. B. V.*

168–4. Lundqvist, G. Stocken i Öje. Ett säkert interglacialfynd [Log in Öje. A definite interglacial find]: Geol. Fören. Stockholm Förh., band 77, häfte 3, p. 317–322, 1955.

The first carbon-14 confirmation in Sweden of an interglacial deposit, first dated as such on geological evidence, is the carbon-14 age of more than 24,000 years for a log found under moraine in Öje.—*D. B. V.*

168–7. Lundqvist, Jan. Interglacialfyndet vid Boliden [Interglacial find near Boliden]: Geol. Fören. Stockholm Förh., band 77, häfte 3, p. 323–326, 1955.

Wood fragments from submorainic deposits at Bjurliden, near Boliden in northern Sweden, have been dated by the carbon-14 method as as least 24,000 years old. As the ice retreated from the area only 9,000 years ago, the deposits are undoubtedly older than the last glaciation. This date is the first real proof of the interglacial age of the much-discussed submorainic deposits of Sweden. G. Lundqvist's paper (see Geophys. Abs. 168–6) concerns an isolated find, not a whole sequence of deposits.—*D. B. V.*

168–8. Gill, Edmund D. Radiocarbon dating for glacial varves in Tasmania: Australian Jour. Sci., v. 19, no. 2, p. 80, 1956.

Wood from the varved clays at Gormanstown, near Queenstown in western Tasmania, has been dated as 26,480±800 years, corresponding to the beginning of Wisconsin glaciation in North America.—*D. B. V.*

168–9. Committee for the Investigation and Correlation of Eustatic Changes of Sea Level. Australian and New Zealand research in eustasy—Part I: Australian Jour. Sci., v. 19, no. 1, p. 17–22; Part II: ibid, v. 19, no. 2, p. 54–58, 1956.

In this report it is mentioned that radiocarbon dating should make possible the elucidation of the much-debated postglacial changes of sea level. The series of dates now available for North America has shown that the eustatic changes and accompanying climatic events took place much faster than was formerly estimated. Radiocarbon dating has also shown that, as previously surmised, certain eustatic movements were worldwide and synchronous. A more planned approach to eustatic studies is recommended for Australasia, including radiocarbon age determinations. In New Zealand a date of 4,600±70 years has been obtained for wood from gravels 15 ft above sea level at Rapahoe, near Greymouth.

In the second part, in the section concerning Victoria, Australia, several radiocarbon dates are quoted. A eucalypt stump 63 ft below present sea level was dated at 8,780±200 years; charcoal from a hearth, presumably of Keilor man, in the upper part of the Keilor terrace at Bragbrook gave a date of 8,500±250 years; wood from the Maribyrnong River 7 miles upstream from Hobson's Bay is 4,820±200 years old; shells from the 25-ft beach in western Victoria are older than 35,000 years and are therefore probably Sangamon; and shells from a platform at a similar elevation to the postglacial platforms are dated as older than 30,000 years, showing that elevation alone is not an infalible criterion of age of raised beaches.—*D. B. V.*

168–10. Nicolaysen, L. O. Solid diffusion in radioactive minerals and the measurement of absolute age: Geochim. et Cosmochim. Acta, v. 11, no. ½, p. 41–59, 1957.

The theory of diffusion of daughter products of radioactive decay schemes from a mineral, manifested in a pattern of discordant age measurements, is examined and developed graphically. Uranium-thorium minerals frequently exhibit the pattern 207/206>207/238>206/238 age; if this pattern is the result of diffusion, the true age of the mineral and the diffusion coefficient governing the loss of Pb can be determined from the graphs given. Examples are given of 4 zircon concentrates and 5 monazites, and Pb diffusion coefficients between 10^{-21} and 10^{-23} cm^2 per sec are obtained. It is concluded that the process of daughter product diffusion is a possible cause of the discordant age measurements and deserves consideration because it can be tested quantitatively.—*D. B. V.*

168–11. Curtis, Garniss H., Lipson, Joseph, and Evernden, Jack F. Potassium-argon dating of Plio-Pleistocene intrusive rocks: Nature, v. 178, no. 4546, p. 1360, 1956.

To aid in the evaluation of the potassium-argon method in dating young rocks, K–A ages are reported for samples of a rhyolite plug and an andesite flow from Sutter Buttes, California, whose ages are well established on geologic evidence. The determinations were made on biotite, using a branching ratio of 0.110 and a decay constant of 0.558×10^{-9}g. The ages determined, 1.57 ± 0.24 and 1.69 ± 0.10 million years for the flow and plug, are in agreement with the Plio-Pleistocene age of the rocks and actually place them in the correct order, although within the limits of error the ages are the same.—*M. C. R.*

168–12. Knopf, Adolph. Argon-potassium determination of the age of the Boulder bathylith, Montana: Am. Jour. Sci., v. 254, no. 12, p. 744–745, 1956.

The age of a sample of granodiorite containing a small pegmatitic schlier rich in potassium feldspar was determined by Reynolds and Folinsbee using the potassium-argon method. With a branching ratio of 0.089, assumed, the age is 87.2 million years; with a branching ratio of 0.11 ± 0.01, the age is 70.8 ± 6.5 million years. These ages are the same order of magnitude as those determined by the lead-alpha method as reported by Chapman, Gottfried, and Waring (see Geophys. Abs. 162–162) and are compatible with the field evidence.—*M. C. R.*

168–13. Fairbairn, Harold W., and Hurley, Patrick M. Radiation damage in zircon and its relation to ages of Paleozoic igneous rocks in northern New England and adjacent Canada: Am. Geophys. Union Trans., v. 38, no. 1, p. 99–107, 1957.

A study of radiation damage in zircon from 42 igneous rocks (mostly granites) from northern New England and adjacent Canada has been made, using X-ray diffractometer measurements to determine unit cell dimensions and alpha counting to determine the activity, or rate of damage to the crystal structure. From previous work changes in C_o (unit cell vertical axis) are known to be proportional to changes in dosage (alphas/mg of sample). The ratio dosage/activity is a measure of the time involved. This ratio corresponds, within experimental error, to ages already determined for many of the rocks used in the present study (Pb–α method for zircon and Sr–Rb method for biotite). Other ratios are invariably low. This feature is discussed in terms of the processing

of samples needed to obtain the lowest possible activity. Fine grinding, close magnetic separation, and aqua regia treatment tend to eliminate surface concentrations and isolated internal clots of radioactive material, the chief causes of high activity and low age ratios. Where, after adequate processing of this kind, ratios are still low relative to standard age determinations, it is suggested that the ratio represents the date of a later metamorphism.—*Authors' abstract*

168–14. Urey, Harold C. Diamonds, meteorites, and the origin of the solar system: Astrophys. Jour., v. 124, no. 3, p. 623–637, 1956.

A series of events during the origin of the solar system is postulated to explain the composition and structure of meteorites. Objects of about asteroidal or lunar mass accumulated early in the history of the solar system (about 4.5×10^9 yrs ago) and were heated to the melting point. These primary objects were subsequently cooled and broken up by collisions, then partially reaccumulated into secondary objects of at least asteroidal size. This accumulation process was probably part of the general process of planet formation. During the breakup and reaccumulation, fractionation of silicate and metal phases occurred, accounting for variation in densitites of the planets. Meteorites were produced from the secondary objects by collisions.

Several age determinations on meteorites are quoted, including unpublished potassium-argon ages of the Pasamonte and Frankfort meteorites (Geiss and Hess, $3.3–3.5\times10^9$ yrs). Potassium-argon ages are recalculated using a half-life of 1.27×10^9 years and a branching ratio of 0.124.—*D. B. V.*

Komarov, A. G. On the question of the age of the gabbro-peridotite formation in the Urals.—See Geophys. Abs. 168–234.

EARTH CURRENTS

168–15. Pěčova, Jana. Přizpěvek ke studiu bludnjch proudo [Contribution to the study of stray (earth) currents]: Československé Akad. Věd Geofys. Ústavu Práce, no. 35, p. 327–342, 1955.

A survey of the natural electric field was made in the region of Pruhovice, 12 km from Praha, because of the proposed location there of a station for recording earth currents. Stray currents of short periods and sharply varying intensity were observed and correlated with the electric street-car system in Praha and with the movement of the electric suburban trains.—*S. T. V.*

EARTHQUAKES AND EARTHQUAKE WAVES

168–16. Murphy, Leonard M., and Cloud, William K. United States earthquakes 1954: U. S. Coast and Geod. Survey Serial 793, 101 p. 1956.

A summary of earthquake activity in 1954 in the United States, Alaska, the Hawaiian Islands, Panama Canal Zone, and Puerto Rico. Noninstrumental results are tabulated chronologically and by area, Information is also tabulated on fluctuations in well-water levels, on instrumental epicenters of the world, strong-motion stations in operation as of December 31, 1954, and shocks recorded and records obtained on strong-motion seismographs. Accelerograph and displacement meter records are shown for a few of the outstanding earthquakes.—*B. T. E.*

168–17. Bullen, K. E., and Bolt, B. A. The South Australian earthquake of 1939 March 26: Royal Soc. New South Wales Jour. and Proc., v. 90, pt. 1, p. 19–28, 1956.

A detailed examination of the instrumental and macroseismic data from the South Australian earthquake of March 26, 1939 (probable epicenter at 31.8° S lat, 138° E long) indicates that the crustal structure of the region between the epicenter and Adelaide bears an important resemblance to that of the New Zealand region. If the position of the epicenter is correct, the phase S_n is apparently not discernible on the Adelaide record; in the New Zealand region the S_n phase has often been undetected. Epicentral distances in Australia can be seriously overestimated by the unguarded use of S—P intervals on seismograms recorded locally.—*V. S. N.*

168–18. Kárník, Vít, and Molnár, Alexander. Nové makroseismické zhodnocení zemětřsení 20. II. 1951 (Nógrad) [New macroseismic study of the earthquake of Nógrad, February 20, 1951]: Československé Akad. Věd. Geofys. Ústavu Práce, Geofys. Sbornik, no. 23, p. 59–67, 1955.

The depth of focus of the earthquake of February 20, 1951, with epicenter near Nógrad, Hungary, was determined by four different methods to be 7 km. Detailed data were used for construction of isoseismal lines; their unusually complicated shape was evidently affected by the differences in structure of the upper layers of the region, which resulted in local variations of seismic intensity. The isoseismal map is included.—*S. T. V.*

168–19. Dollar, A. T. J. The Midlands earthquake of February 11, 1957: Nature, v. 179, no. 4558, p. 507–510, 1957.

According to preliminary reports and results of questionnaires the earthquake of February 11 was felt in an area of perhaps 60,000 square miles. Damage to chimneys, masonry, and brickwork in the epicentral area indicates intensity of VIII (Davison scale) or VII (Modified Mercalli scale). An aftershock on February 12 was also widely felt. The earthquake was probably tectonic, originating in motion on a fault in the basement. A brief discussion of previous earthquakes in the area is included.—*M. C. R.*

168–20. Jhingran, A. G. A note on an earthquake in the Andaman Islands (26th June 1941): Geol. Survey India Records, v. 82, pt. 2, p. 300–307, 1952.

The shock, which was of intensity VIII on the Modified Mercalli scale, was destructive in the Andaman Islands and felt widely throughout eastern and southern India. The epicenter was located from data at Indian observatories at 12°0′ N lat, 92°5′ E long; the depth of focus was apparently shallow. There is geologic evidence for both elevation and subsidence in the epicentral area and therefore a condition of considerable instability is indicated.—*M. C. R.*

168–21. Miller, Henry J. The Oklahoma earthquake of April 9, 1952: Seismol. Soc. America Bull., v. 46, no. 4, p. 269–279, 1956.

Seismograms of the shock of April 9, which centered near El Reno, were marked by a multiplicity of phases and large surface waves. The epicenter was located from instrumental data at lat 35°22.7′N, long 97°47.0′W between the Anadarko Basin and the Nemaha Ridge; the origin time was $16^h\ 29^m\ 33.7^s$ G.m.t.

The numerous phases are best explained as a group of compressional and transverse waves in crustal layers. The velocities of P_4 (P_n) and S_4 (S_n) waves observed were 8.07 and 4.43 kmps. The focus was apparently shallow, of the order of 5 to 10 km.—*M. C. R.*

168–22. Stevens, G. R. Earth movements in the Wellington area: New Zealand Geographer, v. 12, no. 2, p. 189–194, 1956.

The Wellington area was severely shaken by a series of earthquakes in January and February 1855, experienced over an area of about 360,000 square miles. In the vicinity of Wellington a tract of land of 4,600 square miles was elevated from 1 to 9 feet. Well-preserved features or recent uplift, which were present when the settlers arrived in 1840, and recent excavations indicate an uplift before 1840 of about 4 feet. The movement may be the same as that which Elsdon Best records as aiding in the formation of the sand isthmus that now ties the former Miramar Island to the mainland, and it probably occurred between 1400 and 1700 A. D.—*B. T. E.*

168–23. Medvedev, S. V. Zavisimost! seysmicheskikh vozdeystviy ot periodov sobstvennykh kolebaniy sooruzheniy [The dependence of seismic effects on the frequencies of natural vibrations of structures]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 36 (163), p. 80–113, 1956.

Eighty earthquakes for which the spectral characteristics have been computed on the basis of seismograms obtained from different stations in the U. S. S. R. are listed, and the displacements are given which would be produced by these earthquakes on a standard pendulum with natural period of 0.25 sec and the damping coefficient of 0.50.—*S. T. V.*

168–24. Medvedev, S. V. Kolebaniye vertikal'noy sistemy prio gorizontal' nykh seysmicheskikh vozdeystviyakh [The oscillation of a vertical system acted upon by horizontal seismic impulses]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 36 (163), p. 62–79, 1956.

The effect of an earthquake on a structure is determined by the kind of earthquake, by the dynamic properties of the structure, and by the conditions of the common vibrations of the ground and of the structure. For nonsteady vibrations of the ground this effect is conditioned by the spectrum of the acting impulses. The spectrum $K=X_0\phi(T).E(\lambda)$, where ϕ is the function of the period T of the fundamental vibrations and E is the function of the logarithmic coefficient of the damping of these vibrations. Loss of the energy through damping takes place partly in the ground around the foundation of the structure and partly in different elements of the structure itself. The two coefficients ϕ (T) and E (λ) characterize the spectrum of the earthquake; X_0 characterizes the intensity of the earthquake.—*S. T. V.*

168–25. Medvedev, S. V. Vliyaniye sil vnytrennego treniya na kolebaniye zdaniy pri zemletryaseniyakh [The effect of inner friction forces on the vibration of structures during earthquakes]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 36 (163), p. 114–126, 1956.

As the measure of the effect of seismic shocks on different structures Medvedev has previously suggested the quantity $K=X_0\phi(T).E(\lambda)$, (see Geophys. Abs. 168–24).

Experimental data are given of T and λ, obtained on 18 structures erected on different formations ranging from sand and clay to granite and exposed

to the effect of artificial earthquakes produced by various amounts of explosives.

An instrument has been designed for the measurement of the greatest displacement of pendulums with different damping ratios as the result of an earthquake. A table of coefficients that can be substituted for the function $E(\lambda)$ in approximate computations is also given.—*S. T. V.*

168–26. Housner, G. W. Dynamic pressures on accelerated fluid containers: Seismol. Soc. America Bull., v. 47, no. 1, p. 15–35, 1957.

Dynamic fluid pressures developed during an earthquake are important in the design of such structures as tanks and dams. Solutions to the problem have been obtained by methods that require finding a solution of the LaPlace equation that satisfies the boundary conditions. In this paper, impulsive and convective fluid pressures are examined separately and an analysis made of the hydrodynamic pressures developed when a fluid container is subjected to horizontal accelerations. Simplified formulas are given for containers of twofold symmetry, for dams with sloping faces, and for flexible retaining walls.—*M. C. R.*

168–27. Bune, V. I. O klassifikatsii zemletryaseniy po energii uprugikh voln, izluchayemykh iz ochaga [Classification of earthquakes according to the energy of the elastic waves emanating from the focus]: Akad. Nauk Tadzhik SSR Doklady, vypusk 14, p. 31–34, 1955.

Records of earthquakes at a seismological station give information on the energy of elastic waves propagated from the focus, but no data on the energy spent on destructive processes at the focus. The energy of seismic waves from earthquakes in central Asia recorded at stations at different epicentral distances was computed from formulas derived by Gutenberg and Galitzin and on this basis a seismological scale consisting of 12 classes is proposed. The scale is designed so that the energy in each successive class measured in megajoules is 10 times that in the preceding class. A correlation is also reported between the class of an earthquake and the epicentral distance of the furthermost station at which the earthquake is observed. This relation makes it possible to estimate the intensity of an earthquake quickly from the telegraphic communications of a seismic network.—*S. T. V.*

168–28. Puchkov, S. V. O predel'noy sile zemletryaseniy no korennykh skal' nykh porodakh [On the limiting intensity of earthquakes on basement rock]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 8, p. 920–926, 1956.

Analysis of the reports on several destructive earthquakes established the fact that in each earthquake some portion of the city was exposed to much less intensity than the rest. Furthermore this portion always was built on rock and the remaining sections, on alluvium. The difference in intensities of the earthquakes between these two parts ranged from 2 to 4 in a scale of 12. Approximate evaluation of the earthquakes indicates that the intensities of the earthquakes in the less damaged portions were very nearly the same, about 8. Thus, further increase in intensity is the result of the magnification by unconsolidated material over the solid rocks; thus the greatest intensity of the impulses to which granite can be exposed at any point near the earth's surface is 8. This relation should be considered in microzoning.—*S. T. V.*

168–29. Hershberger, John. A comparison of earthquake accelerations with intensity ratings: Seismol. Soc. America Bull., v. 46, no. 4, p. 317–320, 1956.

The maximum accelerations recorded on 108 strong-motion records obtained in 60 earthquakes were compared with the intensity ratings assigned to the places where the records had been obtained. The results seem to show that acceleration alone cannot be used as a measure of intensity.—*Author's abstract*

168–30. Roberts, E. B. Magnitude and intensity scales: Seismol. Soc. America Bull., v. 47, no. 1, p. 13–14, 1957.

Suggests the use of "energy factor" and "local damage rating" instead of "magnitude" and "intensity" because of public confusion of the latter terms.—*M. C. R.*

168–31. Hodgson, John H. Direction of faulting in some of the larger earthquakes of the north Pacific, 1950–1953: Dominion Observatory Ottawa Pubs., v. 18, no. 10, p. 219–252, 1956.

Fault-plane solutions have been obtained for 11 earthquakes in the north Pacific during 1950–53; a total of 24 solutions is now available for this region. They show that faulting in the north Pacific, except in the region from central Alaska to Seattle, Wash., is predominantly transcurrent on steeply dipping planes. In Alaska, British Columbia, and Washington, faulting may be normal, thrust, or transcurrent. The earthquake of November 4, 1952, in Kamchatka was apparently double; the two planes were approximately north-south and east-west in both shocks, but the directions of motion were different.—*M. C. R.*

168–32. Hodgson, John H. Direction of faulting in some of the larger earthquakes of the southwest Pacific, 1950–1954: Dominion Observatory Ottawa Pubs., v. 18, no. 9, p. 171–216, 1956.

The direction of faulting has been determined for 23 earthquakes in the southwest Pacific during 1950–54. These solutions together with five by J. P. Webb and two previously published by Hodgson and Storey (Geophys. Abs. 157–113) indicate a preponderance in this region of strike-slip, or transcurrent faulting on steeply dipping planes. Fault-plane solutions are ambiguous because two orthogonal planes are determined, either of which may be the fault plane, but the line of intersection of the two planes is uniquely determined. This line of intersection is the axis of the displacement couple, and, as such, the one line that undergoes no motion; for that reason it is named the null vector. In the New Hebrides earthquakes, the null vectors are nearly parallel to a vertical plane striking N. 22° W. Null vectors of earthquakes in the Tonga-Kermadec-New Zealand region are nearly parallel to a vertical plane striking N. 24° E. Both strikes are essentially those of the associated geographic feature. The significance of the correlation is not clear.—*M. C. R.*

168–33. Ritsema, A. R. Stress distribution in the case of 150 earthquakes: Geologie en Mijnbouw, jaarg. 19, no. 2, p. 36–40, 1957.

The directions of principal pressure and tension components of stress have been calculated for 150 known earthquake mechanisms, on the assumption that the angle between two possible fault movements is bisected by these directions. The results show that most fault movement is a combination of transcurrent with normal or reverse movement; that at nearly all depths transcurrent move-

ment predominates; that most shallow earthquakes are caused by horizontal pressure (or vertical tension) whereas at greater depths the opposite is the rule; and that in about 70 percent of all shocks at depths of 0.03 to 0.11 *R* in which the movement is predominantly vertical, the tensional stress component was more or less horizontal, whereas in about 70 percent of similar shocks at depths of 0.01 to 0.02 *R* the compressional stress component was more or less horizontal. None of the current geotectonic hypotheses explains the high percentage of transcurrent fault movements at all depths where earthquakes can occur, but the distribution in depth of normal and reverse fault earthquakes does not directly contradict the convection or the contraction theory.—*D. B. V.*

168–34. Gamburtsev, G. A. Sostoyaniye i perspektivy rabot v oblasti prognoza zemletryaseniy [Present state and outlook of studies on the forecasting of earthquakes]: Byull. soveta po seysmologii, no. 1, p. 7–14, 1955.

This is the opening address to a conference of Russian seismologists on methods of forecasting earthquakes. Forecasting involves the place, intensity, and time of the earthquake. As a result of past tectonic activity, the crust of the earth is separated into relatively strong blocks, held together by weaker regions called "seismic seams." These seams are the seismically active portions of the crust. Past experience shows that violent earthquakes in one part of the seismic seam are often followed by similar earthquakes in other parts of the seam, so that it is possible to speak about the migration of the earthquakes along seismic seams. Once a seismic seam is related to a violent earthquake, it must be considered in the future as a probable seismically active region all along its length. Not every seam is now seismically active; activity must be ascertained by seismic statistics, in many places very incomplete and not very reliable. The most difficult problem is the esimation of the time when an earthquake will occur. A possible line of investigation is the observation of the slow movements of the crust, of weak preliminary ruptures, and of possible changes in seismic velocity in deeper strata.—*S. T. V.*

168–35. Bune, V. I. Ob izuchenii seysmichnosti Tadzhikskoy SSR i o rabote Instituta Seysmologii Akademii Nauk Tadzhikskoy SSR po probleme prognoza zemletryaseniy [On the study of the seismicity of the Tadzhik S. S. R. and on the activity of the seismological institute of the academy of sciences of the Tadzhik S. S. R. on the problem of forecasting earthquakes]: Byull. soveta po seysmologii, no. 1, p. 15–30, 1955.

Seismic activity is not satisfactorily shown on existing seismological maps where only the epicenters and intensities of earthquakes are indicated. This method of representation results in an accumulation of epicenters around the station whereas weak earthquakes not in the immediate vicinity remain unnoticed or are described on the basis of only noninstrumental evidence, making proper seismic zoning of the region impossible. Evaluation of the energy at the focus of an earthquake makes possible at least an approximate determination of the intensity of shocks in all parts of the region. More seismological stations and more precise equipment are needed. Study of the changes of the earth's surfaces by inclinometers is also promising as a method of predicting earthquakes.—*S. T. V.*

168–36. Bonchkovskiy, V. F. Itogi raboty Garmskoy ekspeditsii [The results of the activity of the Garm expedition]: Byull. soveta po seysmologii, no. 1, p. 31–39, 1955.

After the occurrence of several destructive earthquakes in the Tadzhik S. S. R. the geophysical institute of the U.S.S.R. academy of sciences organized an expedition to study the seismic conditions in the republic. Between 1945 and 1953, the expedition recorded numerous earthquakes in different parts of the republic, observed telluric currents and magnetic disturbances, and carried on elaborate investigations with high-frequency waves, as well as gravitational and geodetic surveys. One geophysical observatory, several seismological stations, and stations for observation of changes in the inclination of the earth's surface were established. No results of scientific work are given.—*S. T. V.*

168–37. Ostrovskiy, A. Ye. O medlennykh dvizheniyakh zemnoy kory pri sil' nykh zemletryaseniyakh [The slow movements of the earth's crust during violent earthquakes]: Byull. soveta po seysmologii, no. 1, p. 40–45, 1955.

G. A. Gamburtsev has suggested that slow seismic movements with periods ranging from 10 seconds to 2 hours precede the occurrence of earthquakes and thus can serve as forecasters. Several specially constructed long-period electrodynamic seismoinclinometers were installed at Garm seismic station to observe these slow seismic movements. The magnification of the instruments ranged from 10^3 to 10^5 or more. On the records of earthquakes at epicentral distances of less than 2,000 km, a wave of very low frequency, P_0, preceded the arrival of the P wave. At an epicentral distance of 1,500 km the difference in arrival times was about 11 minutes. P_0 is not always recorded, especially for very distant earthquakes, but when recorded can be used as the warning of the coming earthquake.—*S. T. V.*

168–38. Medvedev, S. V. O seysmometricheskikh nablyudeniyakh v Ashkhabadskoy zonhe [Seismometric observations in the Ashkhabad zone]: Byull. soveta po seysmologii, no. 1, p. 46–66, 1955.

Effects of the violent earthquake of October 6, 1948, near Ashkhabad, Turkmen S. S. R., were studied by six groups of seismologists and geologists from immediately after the earthquake until 1953. Numerous buildings were destroyed and in many places the ground contained cracks as much as 60 cm wide. The relative vertical displacements of the sides of the cracks were as much as 90 cm. In many places water pipes were broken or were pushed out of the ground. The isoseismal lines of this earthquake were elongated ellipses; the epicenter was evidently not a point but a line between lat 38.03° N, long 58.31° E and lat 37.75° N, long 58.65° E. The shape suggests a structural relation between the Ashkhabad earthquake and those of Kransnovodsk (1952) and Kazandshik (1946). The conclusion seems to be justified that these three cities are situated on the same "seismic seam," as suggested by G. A. Gamburtsev. The earthquake was followed by an unusually large number of aftershocks (more than several thousand) recorded as local earthquakes from foci at depths of 10 to 30 km. Striking local differences in the intensity of the shocks were observed apparently as the result of differences in the structure of the upper layers of the crust.—*S. T. V.*

168–39. Gubin, I. Ye., and Vasil'yeva, L. B. Seysmotectonicheskiye usloviya Gissarskoy doliny [Seismotectonic conditions of the Gissar Valley]: Byull. soveta po seysmologii, no. 1, p. 67–84, 1955.

The Gissar Valley (near Stalinabad) is a deep graben about 70 km long and only 18 km wide in its largest cross section. The surrounding region is seismically very active and has been well investigated geologically. Earthquakes are very shallow; often the depth is only about 5 km. Because the structural development at depth is reflected at the surface, use of the seismotectonic method of evaluating the probability of future earthquakes is facilitated. On the basis of geologic investigations and seismologic records the five earthquakes were successfully predicted. This success is considered proof of the reliability of the seismotectonic method.—*S. T. V.*

168–40. Shamina, O. G. Chastotnyy analiz seysmicheskikh kolebaniy [Frequency analysis of seismic oscillations]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 8, p. 896–911, 1956.

Knowledge of the spectral composition of a seismic impulse is of great importance in problems of seismic zoning, in problems related to the studies of the earth's crust, and often in seismic prospecting. To determine the spectrum a precise recording is made of the impulse to be analyzed, using an apparatus similar to a magnetic tape recorder. The recorder sends the impulse into a circuit containing a Rodman's frequency analyzer, capable of analyzing periodic oscillations ranging from 100 to 5,000 cycles per sec with an error not exceeding ±7 cycles. The analyzer is a heterodyne circuit provided with a negligible resistance, thus giving a very sharp point of interference. Several examples are given.—*S. T. V.*

168–41. Gotsadze, O. D. Opredeleniye polozheniya prelomlyayushchikh i diffragiruyushchikh poverkhnostey zemnoy kory po uglovym anomaliyam seysmicheskogo lucha [Determination of the position of refracting and diffracting surfaces in the earth's crust from anomalies in the angle of seismic ray]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 9, p. 1107–1113, 1956.

Comparison of the direction of the incoming seismic ray determined from the components of the first arrivals of longitudinal waves at a station with the azimuth of the epicenter and angle of emergence determined from other seismological data can provide information on structural details in the region surrounding the station. A graphoanalytic procedure is given for determination of the position of the refracting plane in the earth's crust near the station on the basis of the deflection which the seismic ray undergoes due to its presence. Several examples are given.—*S. T. V.*

168–42. Gutenberg, B[eno]. Effects of ground on shaking in earthquakes: Am. Geophys. Union Trans., v. 37, no. 6, p. 757–760, 1956.

Records of nearby earthquakes recorded simultaneously at the Seismological Laboratory, located on granite, and on the campus of the California Institute of Technology, located on alluvium, show that the first wave of a new phase frequently records with rather small differences at the two stations; however, if the following waves had periods of less than about two seconds they were recorded with appreciably larger amplitudes on the campus than at the Seismological Laboratory. Large amplitudes continued on the campus appreciably

longer than at the Seismological Laboratory. Data available for locations on poor ground show that there the maximum amplitudes may be as much as ten times as large as those recorded at the Seismological Laboratory under otherwise equal conditions. Considering the importance of such results for engineering seismology it is intended to continue this research on a larger scale.—*Author's abstract*

168–43. Gutenberg B[eno]. Comparison of seismograms recorded on Mount Wilson and at the Seismological Laboratory, Pasadena: Annales Géophysique, tome 12, no. 3, p. 202–208, 1956.

On seismograms recorded between 1932 and 1951 by standard Wood-Anderson seismographs on Mount Wilson and at the Seismological Laboratory, Pasadena, Calif., the amplitudes of body waves of periods of a few seconds are twice as large at Mount Wilson as at the Laboratory. The ratio for surface waves of distant shocks is about 1¼. In most nearby shocks the amplitudes of the first waves of the *P* and *S* phases are larger at Pasadena, whereas the succeeding waves are larger on Mount Wilson. Relatively large motion frequently lasts several seconds longer on Mount Wilson than at Pasadena. Wave periods in *P* and *S* phases on Mount Wilson are about two-thirds those recorded at Pasadena. Topography and the degree of damping below the stations may possibly cause some of these differences; however, there are some unexplained great dissimilarities of corresponding portions of the records.—*B. T. E.*

168–44. Bullen, K. E. Note on the phase PKJKP: Seismol. Soc. American Bull., v. 46, no. 4, p. 333–334, 1956.

R. O. Hutchinson has reported that examination of seismograms recorded from 1946 to 1954 at Tucson indicates no trace of *PKJKP* on the only two records suitable for testing the existence of the phase. However, in one record the large *P′* trace amplitude is probably not associated with the branch of the *P′* curve that corresponds to *PKIKP*, so that the comparison of *PKJKP* and *PKIKP* amplitudes is not possible; and in the other the large amplitude at Tucson seems to be a freak occurrence.—*M. C. R.*

168–45. Press, F[rank], and Gutenberg, B[eno]. Channel *P* waves π_g, in the earth's crust: Am. Geophys. Union Trans., v. 37, no. 6, p. 754–756, 1956.

Channel *P* waves have been identified on seismograms of the Kern County, Calif., earthquake of July 21, 1952, at 11 of 19 stations between 18° and 38°. The mean velocity was 6.09 ± 0.06 kmps. The amplitude of the wave was small and its occurrence, erratic. The weakness of π_g, in contrast to the strength of L_g, is attributed to propagation in a channel involving at least one interface, most probably the surface at which total reflection of *S* and partial reflection of *P* occurs.—*M. C. R.*

168–46. Kondorskaya, N. V. Vydeleniye volny *sP* pri neglubokikh zemletryaseniyakh i eye ispol'zovaniye dlya opredeleniya glubiny ochaga [Identification of the *sP* wave in shallow earthquakes and its use in determining the depth of focus]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 36 (163), p. 35–47, 1956.

The *sP* wave can be used to determine the focal depth of an earthquake when the focus is within the crust. *sP* can be identified only after careful analysis of the records; for example, by comparison with the calculated displacements of the

longitudinal wave and the *SV* component of the transverse wave. The depth of focus can be determined from the *sP—P* or *sS—S* intervals. Examples are given for 13 earthquakes in central Asia, India, Turkey, Greece, and Japan.—*S. T. V.*

168–47. Vvedenskaya, N. A. Vydeleniye volny *sP* na zapisyakh glubokikh zemletryaseniy Sredney Azii [Identification of the *sP* wave on the records of deep earthquakes in central Asia]: Akad. Nauk SSSR Geofiz., Inst. Trudy, no. 36 (163), p. 25–34, 1956.

A discussion of the identification of *sP* on seismograms of deep-focus earthquakes in Pamir and Afghanistan and its use for determining the depth of focus. The *sP* wave must be identified on the basis of its kinematic and dynamic characteristics and by comparison of the theoretical and observed traveltime curves; it requires a sufficient number of seismic stations in a region, all equipped with identical seismographs. An *sP* is usually recognized because it precedes the *S* wave (*sP* has an apparent velocity of about 7.9 kmps, almost the same as that of the *P* wave). The intensity of *sP* is affected by the direction of vibration of *S; sP* will not be produced if there is no *SV* component. The depth of the focus can be determined from the time of arrival of *sP;* 1-second differences in $t_{sP}-t_P$ correspond to differences of 6 km in depth. An example is given of identification and use of *sP* on the records of the earthquake of June 12, 1951, at 36.7° N lat, 70.7° E long, depth 240 km.—*S. T. V.*

168–48. Kárník, Vít. Zur graphischen Distanz- und Azimutbestimmung eines Epizentrums [Graphical determination of the distance and azimuth of an apichenter]: Československé Akad. Věd Geofys. Ústavu Práce, no. 22, p. 45–58, 1955.

Two nomograms are given for determination of epicentral distance $\triangle$, one for $\triangle<25°$, the other for $\triangle$ 165°. Two other nomograms are used for determination of the azimuth. With careful use, the errors are within $\pm 0.1°$ for distance and $\pm 1°$ for azimuth.—*S. T. V.*

168–49. Satō, Yasuo, and Matumoto, Tosimatu. On the relay computer designed for correlogram analysis: Tokyo Univ. Earthquake Research Inst. Bull., v. 34, pt. 3, p. 279–281, 1956.

A description of a computer for spectrum analysis.—*M. C. R.*

168–50. De Bremaecker, J. Cl., and Michel, Jean. An automatic spot brightener: Seismol. Soc. America Bull., v. 46, no. 4, p. 331–332, 1956.

The automatic spot brightener consists of an auxiliary beam of light directed on one of the moving mirrors of the seismographs or galvanometers, and from there on a photocell. Interruption of the light on the cell during a shock short-circuits a resistance and brightens the spots. A circuit diagram is included.—*M. C. R.*

168–51. Eaton, J. P. Theory of the electromagnetic seismograph: Seismol. Soc. America Bull., v. 74, no. 1, p. 37–75, 1957.

Although the development of the first moving-coil electromagnetic seismograph and a primitive theory to account for its behavior date back almost fifty years, the responses of only a few simple types of these instruments have had adequate theoretical treatment. This lack of theory restricted, but did not stop, the

development of other designs for which no adequate theory existed. Confusion and controversy have arisen over the behavior of these later designs. Some work has been done on obtaining magnification curves for these instruments directly by the use of shaking tables or other artificial driving devices. On the whole, however, instruments of this type now in use simply are not calibrated.

An attempt guided by the work of previous investigators has been made to clarify further the behavior of electromagnetic seismographs by extending the theoretical treatment. Three new types of seismographs (more properly "adjustments" of seismographs), each of which includes the classical Galitzin as a limiting case, are proposed. Methods for adjusting and calibrating these instruments are outlined.

Since overcritical damping is employed in two of the adjustments proposed, a method is given for determining the damping constant of an overdamped galvanometer or seismometer.—*Author's abstract*

168–52. Herrin, Eugene. The reliability of North American seismological stations: Seismol. Soc. America Bull., v. 47, no. 1, p. 1–5, 1957.

Estimates are given for the reliabilities of fifty-eight North American seismic stations, based on I. S. S. *P*-time residuals of Mexican earthquakes for 1941, 1942, 1943, and 1944. The ten most reliable stations were found to be Tinemaha, Riverside, Pasadena, Mount Wilson, Tucson, Lick, Weston, Palomar, Haiwee, and Seven Falls. The standard deviation of a single *P* arrival for the more reliable stations is ± 2.0 seconds or greater.

A systematic difference in travel times between the California stations and eastern stations, and particularly between Ottawa and the Pasadena group, is strongly suggested. *P* arrivals at Ottawa are about one second faster than for the Pasadena group.—*Author's abstract*

168–53. Hull, Louis V. The new Dallas Seismological Observatory at Southern Methodist University; Seismol. Soc. America Bull., v. 46, no. 4, p. 321–330, 1956.

The station began operations on December 14, 1953, in the basement of the Fondren Science Building on the university campus. The equipment consists of three Benioff seismometers with both short-period (1 sec) and long-period (70–90 sec) galvanometers.—*M. C. R.*

Toperczer, Max. The Wien-Kobenzl geophysical observatory.—See Geophys. Abs. 168–224.

EARTH TIDES AND RELATED PHENOMENA

168–54. Jobert, Georges. Influence de la structure de la croûte sur les déformations causées par les marées oceaniques [Effect of crustal structure on the deformations caused by ocean tides]: Acad. Sci. Paris Comptes Rendus, tome 244, no. 2, p. 227–230, 1957.

Ocean tides produce a bending of the earth's crust that is often greater than that caused directly by the tides of the solid earth as a whole. This indirect effect, which must be eliminated in studies of earth tides, is calculated for a heterogeneous medium with the assumptions that the elastic isotropic body occupies the half $z>0$, that its elastic properties depend only on depth z, and that it is subjected only to surface pressures described by a single coordinate, two conditions of symmetrical revolution about a vertical axis O_z, and plane de-

formations constant along parallel to O_y. Numerical application of the formulas derived gives a value for the depth $1/m$ (corresponding to a law of exponential variation of rigidity with depth) $[(3k + 4)/6(k + 2)]10^8$; or for $k=1$, $\lambda=\mu$, $\sigma=0.25$, $1/m=389$ km. This depth is about half that obtained from the law of variation given by Bullen in determining the depth z at which $\mu(z)=e.\ \mu(o)$.—*D. B. V.*

168–55. Lassovszky, Károly. A lunisoláris hatás amplitudóviszonyának meghatározása a Budapesten 1951-ben 37 napon át végzett gravimeterészlelésköl [Determination of the amplitude ratio of the lunisolar effect from gravimeter observations made at Budapest during 37 days in 1951 (with German summary)]: Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, kötet 5, szám 3, p. 9–20, 1956.

The amplitude ratio (d) of the lunisolar effect has been calculated from data of the observations made simultaneously with two gravimeters in Budapest, at half-hour intervals over a 37-day period in 1951 (see also Geophys. Abs. 153–14392 and 158–5). Using the formula $d=y/x$, where x is the calculated theoretical value of the lunisolar effect and y is the observed value corrected for instrumental drift, 1,685 observations made with the Heiland gravimeter no. 40 give a mean d value of 1.197, and 1,638 readings with the no. 66, a mean value of 1.203; therefore, the probable value of the amplitude ratio, from the Budapest observations, can be considered to be 1.20.—*D. B. V.*

168–56. Stoyko, Nicolas. L'horloge atomique et l'irregularité de la rotation de la Terre [The atomic clock and the irregularity of the rotation of the earth]: Acad. Sci. Paris Comptes Rendus, tome 244, no. 1, p. 43–45, 1957.

The mean discrepancy between the variations in velocity of the earth's rotation calculated from M. L. Essen's cesium atomic resonator and those extrapolated from the "Bulletin horaire" time series is 0.004 seconds, proving the accuracy of this atomic clock. In the period considered (June 1955 through October 1956) no sharp variations in velocity of rotation were noted beyond the seasonal variations.—*D. B. V.*

168–57. Melchior, Paul J. Sur l'effect des marées terrestres dans les oscillations du niveau du Lac Tanganika à Albertville [On the effect of earth tides on the oscillations of the water level of Lake Tanganyika at Albertville]: Acad. Royale Belgique Bull., Cl. Sci. 5e sér., tome 42, no. 3, p. 368–371, 1956.

An harmonic analysis by Darwin's method was made of the micromarigraph records at Albertville (lat 5°54′ S; long 29° E) for a period of 29 consecutive days (12 February – 12 March 1947) relatively free of perturbation. Comparison of calculated and observed values indicates the amplitude of the static tides of the Lake Tanganyika was reduced on the order of 0.56 ± 0.06 by the terrestrial tides.—*B. T. E.*

ELASTICITY

168–58. McCutchen, Wilmot R. A treatment of self-gravitational strains in the earth: Am. Geophys. Union Trans., v. 38, no. 1, p. 95–98, 1957.

Self-gravitational forces acting alone on a spherical body produce non-hydrostatic strain states. An analysis of these strains and attendant deformations,

as applied to the earth, shows that an extension type of strain, characterized by radial extrusion of material, exists in the upper mantle. Also, a radial displacement at the earth's surface of about 188 km can be attributed to this self-gravitational attraction.—*Author's abstract*

168–59. Jobert, Nelly. Evaluation de la period d'oscillation d'une sphère élastique heterogène, par application du principe de Rayleigh; (vibrations propres de rotation) [Evaluation of the period of oscillation of a heterogeneous elastic sphere, by application of Rayleigh's principle; (natural vibrations of rotation)]: Acad. Sci. Paris Comptes Rendus, tome 243, no. 17, p. 1230–1232, 1956.

The periods of oscillations of rotation are calculated, according to the Rayleigh principle, for three spheres: one in which a homogeneous shell surrounds a liquid core, a heterogeneous sphere in which density and rigidity vary along the radius, and a sphere in which a heterogeneous shell surrounds a liquid core. In all three the period is smaller than that of the earth. By using Bullen's data for variations of density and rigidity of the earth, a period of 44 minutes is obtained, still considerably less than the oscillations of 57-minute period registered by Benioff for the Kamchatka earthquake of November 4, 1952. One can thus ask whether these truly represent the oscillations of a perfectly elastic earth.—*D. B. V.*

168–60. Ogurtsov, K. I. Kolichestvennyye issledovaniya volnovykh protsessov v uprugom poluprostronstve pri razlichnykh tipakh vozdeystviya [Quantitative investigations of the wave processes in elastic semispace in response to different types of exciting forces]: Leningrad Univ. Uchenyye Zapiski, no. 208, p. 142–220, 1956.

A brief discussion of the general solutions reported in previously published investigations of the dynamic theory of elasticity, especially the studies of the mathematicians of Leningrad University, and a numerical study of the solutions to evaluate the relative importance of individual waves in the general spectrum of the movements. The most intense waves at different distances from the center of excitation are determined and the results are presented as graphs of the displacement at different points or along certain characteristic planes.—*S. T. V.*

168–61. Alekseyev, A. S., and Tsepelev, N. V. Intensivnost' otrazhennykh voln v sloisto-neodnorodnoy uprugoy srede [The intensity of reflected waves in a stratified heterogeneous elastic medium]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 9, p. 1021–1035, 1956.

A mathematical analysis of the reflection of waves from curvilinear boundary surfaces in elastic heterogeneous media on the basis of the energy relations.—*S. T. V.*

168–62. Vaněk, Jiří. On the magnitude of the transitional zone for elastic waves produced by different shock-exciting functions: Československé Akad. Věd. Geofys. Ústavu Práce, Geofys. Sbornik, no. 25, p. 79–89, 1955.

An explosion in a homogeneous, isotropic, and perfectly elastic medium produces spherical waves spreading in all directions from the shot point. Beyond a certain distance from the shot point the amplitudes of the waves decrease according to the law $1/r$, but in the immediate vicinity of the shot according to the relation

$1/r^k$, where k is greater than 1. The distance R_c where the relation $1/r^k$ is replaced by $1/r$ is affected by the process of the explosion; that is, by the form of the shock-exciting function that represents the variation of the effective pressure with time and has in general the form $p(t)=\sigma t^n e^{-at}$. Three special cases are investigated: $p(t)=\sigma$; $p(t)\sigma e^{-at}$; and $p(t)=\sigma t e^{-at}$. The results are represented in tables and graphs. The more rapid decrease of amplitude in the vicinity of the shot point results from the fact that the velocity of the shock wave exceeds that of the seismic wave in the medium under consideration.—*S. T. V.*

168–63. Ivakin, B. N. Podobiye uprugikh volnovykh yavleniy [The similarity of the elastic wave phenomena] Pt. 1: Akad. Nauk SSSR Izv. Ser. geofiz., no. 11, p. 1269–1281; Pt. 2: ibid., no. 12, p. 1384–1388, 1956.

Part one includes a brief presentation of the theory of dynamic similarity as applied to model studies of seismic phenomena. Several relations between the mechanical properties of the model materials and those of the ground which must be satisfied in order to produce comparable wave movements are given; geometric units (length, area, volume) and the units of time must also be related.

In the second part the criteria and the coefficients of similarity are derived for wave movements: first for perfectly elastic media, and then for actual physical bodies. In the development the wave equation is derived and then it and the equations expressing boundary and initial conditions are transformed into dimensionless form. From the system of dimensionless equations thus obtained, criteria of similarity are established for specific materials.—*S. T. V.*

168–64. Petrashen', G. I. O ratsional 'nom metode resheniya zadach dinamicheskoy teorii uprugosti v sluchaye sloisto-izotropnykh oblastey s ploskoparallel'nymi granistsami razdela [The rational method of solving problems of the dynamic theory of elasticity for stratified isotropic media with plane-parallel separating boundaries]: Leningrad Univ. Uchenyye Zapiski, no. 208, p. 5–57, 1956.

A review of different methods of solving the problems of the dynamic theory of elasticity including those of Rayleigh and Lamb, both of whom employed the Fourier development method in their studies, Smirnov and Sobolev who introduced the functional-invariant method, using complex variables, and Petrashen' and his pupils at Leningrad University, who use the method of Mellin's contour integrals and the theory of Laplace transformation. Emphasis is placed on use of the Laplace transformation and a comparison of the details of this procedure with those of other methods.—*S. T. V.*

168–65. Petrashen', G. I., and Uspenskiy, T. N. O rasprostranenii voln v sloisto-izotropnykh uprugikh sredakh [The propagation of waves in stratified media, isotropic within individual elastic strata]: Leningrad Univ. Uchenyye Zapiski, no. 208, p. 58–141, 1956.

Vibrations of the medium are assumed to be produced by a force $f(t)$ which can be: a variable force acting normally to the stratification and applied either to the top layer or to any intermediate layer; a force tangential to the top layer or a combination of radial forces; a point source producing radial pressure around a point in one of the intermediate layers; or a single force applied tangential to a point of the top layer in the direction of the x-axis. The analysis includes use of complex variables and Mellin's contour integration.—*S. T. V.*

168–66. Petrashen', G. I., and Yenal'skiy, V. A. O nekotorykh interferentsionnykh yavleniyakh v sredakh, soderzhashchikh tonkiye ploskoparallel'nyye sloi. [Certain interference phenomena in media containing thin plane-parallel layers] Part 1: Akad. Nauk SSSR Izv. Ser. geofiz., no. 9, p. 1009–1020; part 2, ibid. no. 10, p. 1129–1144; part 3, ibid. no. 11, p. 1241–1257, 1956.

Mathematical discussion of the propagation of transverse waves of *SH* type in media of two and three layers with plane parallel boundary surfaces, and of different densities and elastic properties. The different media are rigidly connected; that is, the components of the displacement and stress vectors remain continuous on the boundary planes. In part 1, the following problems are analyzed: Two elastic semispaces separated by a thin elastic layer: three-layer medium composed of a thick upper layer, a thin intermediate layer, and semispace; a two-layer medium composed of a thin elastic layer over a semispace. In part 2, the roots of the characteristic equation established in the first part of the study are analyzed, especially the behavior of the *SH* wave as affected by different properties of the different strata. In part 3, special attention is paid to the wave motion on a surface of ground either covered with a thin layer of slightly different mechanical properties or containing such a layer at a certain depth. The general solutions of the problem are finally represented as formulas convenient for practical applications.—*S. T. V.*

168–67. Manukhov, A. V. Ob approksimatsii tonkikh sloyev vyrozhdennymi modelyami [The approximation of thin layers with degenerated models]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 12, p. 1400–1410, 1956.

In solving problems of the propagation of seismic waves through a stratified medium, there are mathematical difficulties when one of the intermediate layers is very thin; that is, when its thickness is much less than a wavelength. By theoretical analysis and by reference to published results of related experiments it is shown that the usual formulas derived for the reflection and refraction in finite or even infinite media are not applicable to the case of a very thin layer. However, the phenomena taking place on such boundary can be approximately represented by the reflection and refraction on an appropriately selected membrane. This conclusion is of importance in model studies of wave phenomena.—*S. T. V.*

168–68. Stoneley, Robert. The transmission of Rayleigh waves across an ocean floor with two surface layers—Part 1: Theoretical: Seismol. Soc. America Bull., v. 47, no. 1, p. 7–12, 1957.

The theoretical part of this paper is a discussion of the propagation of waves of Rayleigh type in an elastic medium with a horizontal double surface layer, above which is a uniform layer of liquid. This model is based on seismic determinations of the velocities of explosion waves in the layers below the ocean bottom, and the equation giving the wave velocity as a function of wave length is derived as a determinantal equation of the eleventh order.

The numerical solution of this equation and the application to the propagation of Rayleigh waves across the ocean floor will be given in Part II.—*Author's abstract*

168–69. Strick, E., and Ginsburg, A. S. Stoneley-wave velocities for a fluid-solid interface: Seismol. Soc. America Bull., v. 46, no. 4, p. 281–292, 1956.

Numerical solutions of the Stoneley-wave equation have been determined for 13 values of the density ratio of solid to liquid (ranging from 0.20 to 3.00) and 9 values of Poisson's ratio of the solid (0.05 to 0.45) where the ratio of the dilatational velocity in the fluid to the rotational velocity in the solid is greater than 0.10 and less than 10.00. Results are shown graphically.—*M. C. R.*

168–70. Kanai, Kiyoshi, and Yoshizawa, Shizuyo. Relation between the amplitude of earthquake motions and the nature of the surface layer. IV. (The case of finite train): Tokyo Univ. Earthquake Research Inst. Bull., v. 34, pt. 2, p. 167–184, 1956.

In a finite train of harmonic plane waves transmitted to a doubly stratified surface layer, the maximum amplitude is reached at the free surface when the period is such that a node coincides with the bottom boundary, and is extremely large when there are nodes at both the first and bottom boundaries. Spectral response of amplitude of the surface layer is very irregular because of interference of waves reflected at the various boundaries. For very short period incident waves of a finite train there may be nodes in the surface layer and correspondingly small amplitudes. When the period of the finite train waves is too large to have a node in the surface layer, the maximum value at the surface may approximate the value for an infinite train. The amplitude does not necessarily vary directly with length of the train. In nature, vibrations short enough to produce nodes in the surface layer (higher harmonics) seldom occur, so that in analyzing earthquake motion it is reasonable to assume that the surface consists of more than two layers if there are more than two peaks in the spectral response of amplitude. (See also Geophys. Abs. 162–131, 162–132, 163–79.)—*D. B. V.*

168–71. Tocher, Don. Anisotropy in rocks under simple compression: Am. Geophys. Union Trans., v. 38, no. 1, p. 89–94, 1957.

Compressional velocities through samples of several types of rocks have been measured while the samples were subjected to simple compression in a hydraulic press. Velocity measurements were made in directions parallel to and perpendicular to the direction of the compression, with the amount of compression varying from zero up to the rupture point. All measurements were made at room temperature and with no confining pressure other than that of the atmosphere.

Velocities in a direction parallel to the compression increased with compression in a manner somewhat similar to the increase found by other workers in samples subjected to hydrostatic pressures. Velocities in a direction perpendicular to the compression also increased, but at a much lower rate. The differences in the two velocities amounted to over ten percent in some cases.

The differences in velocities are large enough to suggest the possibility of making a rough determination of the state of strain in the neighborhood of a recognized active fault which is known or suspected to be near vertical. Possible applications toward the prediction of rockbursts are also suggested.—*Author's abstract*

168–72. Mogi, Kiyoo. Experimental study of diffraction of water surface waves: Tokyo Univ: Earthquake Research Inst. Bull., v. 34, pt. 3, p. 267–277, 1956.

Height and front of diffracted waves in water caused by obstacles such as a semi-infinite plate, a slit, a plate of finite length, and a cylinder were observed experimentally and compared with theoretical calculations. Good agreement was found with Sommerfeld's solution for diffraction by a semi-infinite plate, and approximate solutions for the cases of a slit and a finite plate were obtained by superposition of the solutions for a semi-infinite plate.—*M. C. R.*

168–73. Hughes, Darrell S., and Maurette, Christian. Variation of elastic wave velocities in basic igneous rocks with pressure and temperature: Geophysics, v. 22, no. 1, p. 23–31, 1957.

The dilatational and rotational wave velocities have been measured as functions of pressure and temperature for three gabbros, two basalts and a dunite. The pressure range was 200–6,000 bars. The temperature range was 25° to 300° C and 400° C for one sample. The maximum pressure is equivalent to 23 km of depth and the highest temperature is believed to correspond to 25 km. The data indicate a tendency for the velocity to reach a maximum somewhere between 10 and 20 km and then decrease slightly.—*Authors' abstract*

168–74. Balakrishna, S. Transmission of ultrasonic waves through rocks: Indian Acad. Sci. Proc., sec. A, v. 41, no. 1, p. 12–14, 1955.

Ultrasonic velocities were determined in 6 monomineralic rocks (3 quartzites, 3 limestones) by the total internal reflection method in order to study the relations of longitudinal and torsional velocities to grain size. In coarse-grained rocks, velocities are found to be low and absorption high; in fine-grained rocks, velocities are high and absorption low.—*D. B. V.*

168–75. Tsareva, N. V. Rasprostraneniye uprugikh voln v peske [The propagation of elastic waves in sand]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 9, p. 1049–1053, 1956.

Impulses of frequencies as high as 200 kc were sent through short pipes filled with sand of specific moisture content and subjected to a definite pressure. The velocity of the propagation of the longitudinal and transverse waves in dry sand was found to depend on pressure; that is, in nature, on the depth below the surface. The velocity was approximately proportional to the root of the sixth power of the depth (measured in meters). The velocity of the longitudinal waves in dry sand was 120 to 150 m per sec with no external pressure and 900 to 980 m per sec under pressures of 65 kg per cm^2, corresponding to a depth of 370 to 400 m. The velocity of transverse waves in dry sand is about 1.5 to 1.7 times smaller than that of longitudinal waves. In water-saturated sand the velocity of the longitudinal waves is almost independent of pressure. The velocity of the transverse waves in water-saturated sand is the same as that in dry sand.—*S. T. V.*

ELECTRICAL EXPLORATION

168–76. Khalfin, L. A. Pole tochechnogo istochnika pri nalichii polusferoidal' noy vyyemki [The field pattern of a point source in the presence of a hemispheroidal indentation]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 10, p. 1200–1206, 1956.

By use of the method of images the field pattern produced in the ground by a point source placed on the surface of the earth in which there are hemispheroidal indentations can be determined. Formulas are given for the value of the potential gradient at points in the coordinate planes *xz*, *xy*, and *zy*.—*S. T. V.*

168–77. Al'pin, L. M. Nesimmetrichnoye (uglovoye) zondiroyaniye [Asymmetric (angular) electrical surveying]: Prikladnaya geofiz., vypusk 14, p. 65–96, 1956.

By placing three electrodes in one line and the fourth out of line or removed to infinity, or by placing the measuring electrodes in different azimuths, it may be possible to obtain additional relations and complementary curves and thus more detail on geologic conditions in the plane of the measurements without the introduction of the effects of deeper layers. Disturbances caused by induction and the building up of the field can be eliminated; topographic obstacles met with in the surveyed area can be avoided by appropriate selection of the angles between the lines of electrodes. Where electrode spacing is great, the intensity of the feeding current in rectangular arrangement does not increase as rapidly as in the Wenner configuration.—*S. T. V.*

168–78. Berdichevskiy, M. N., and Petrovskiy, A. D. Metodika vypolneniya dvustoronnikh ekvatorial'nykh zondirovaniy [Procedures of bilateral equatorial electrical surveying]: Prikladnaya geofiz., vypusk 14, p. 97–114, 1956.

An important drawback in the Wenner method is the necessity of using long electrode spacings. Deep vertical profiling can be made much more easily by replacing the Wenner configuration with a dipole setup in two- or four-sided arrangements of the electrodes. In one such, the equatorial arrangement, electrodes *AB* and *MN* are placed parallel to each other so that the midpoints of the segments *AB* and *MN* are on the same perpendicular to the lines *AB* and *MN*. Working formulas are derived for the dipole equatorial arrangement of the electrodes. Possible sources of errors and inaccuracies are analyzed. The proposed setup can be used to good advantage in profiles 10 km long over formations of low electric resistivity and 15 to 25 km long where there is high resistivity in the geologic profile. The intensity of the current used must be 35 to 40 amp.—*S. T. V.*

168–79. Belluigi, Arnaldo. Principi d'equivalenza geoelettrica ed erroneità di alcune leggi di composizione nei sondaggi elettrici su terrenti a più strati [Principles of geoelectric equivalence and the error of some distribution laws of electric methods for multilayer ground]: Geofisica Pura e Appl., v. 34, p. 57–65, 1956.

A synthesis of Belluigi's work and results on the principles of the equivalence of electric soundings.—*B. T. E.*

168–80. Belluigi, Arnaldo. Su una vexta quaestio di gerarchia nei dispositivi dei sondaggi elettrici [A moot question of the graduated arrangement of electric methods]: Geofisica Pura e Appl., v. 34, p. 51–56, 1956.

From the simplest method of measuring resistivity of the ground with a single pole, all other methods (Wenner, Schlumberger, and so on) can be derived. This raises the practical possibility of determining the apparent resistivity curve of one configuration from all others. The two-point method is completely

equivalent to the single-pole method and it is unnecessary to graduate the electrode configurations to transfer from one to the other.—*M. C. R.*

168–81. Kunetz, G[éza], and Chastenet de Géry, J[érôme]. La représentation conforme et divers problèmes de potentiel dans des milieux de "perméabilité" differente [Conformal mapping and various problems of potential in media of different "permeability"]: Rev. Inst. Français du Pétrole, v. 11, no. 10, p. 1179–1192, 1956.

Techniques of conformal mapping are applied to a series of two-dimensional potential distribution problems. Cases considered are those in which two or more homogeneous mediums of different physical properties are separated by surfaces of various shapes, such as a vertical fault, valley, anticline, double undulation in resistant basement, uniform cover over a buried anomaly, anticline with horizontal substratum, narrow outcrop, underwater measurements, and folded substratum of finite resistivity. A particularly useful technique, exchange of equipotentials and lines of current, is illustrated for the last example. Conformal mapping can be applied not only to the interpretation of electrical surveys but also to problems of the oil industry, such as those concerning the flow of liquids in mediums of different permeabilities.—*D. B. V.*

168–82. Bukhnikashvili, A. V. K voprosu o metodike postanovki elektroazvedki rudnykh mestoroshdeniy [On the procedure of prospecting for ore deposits by electric methods]: Akad. Nauk Gruzinskoy SSR Soobshcheniya, tom 16, no. 10, p. 775–779, 1955.

The electro-radiometric laboratory of the Geophysical Institute of the Georgian SSR has been exploring for ore deposits, especially hydrothermal deposits, by the electric resistivity method for several years. Use of this method is usually based on the assumption that the ore deposit is a conductive body surrounded by a medium of much higher electrical resistivity, although the opposite relation may hold or the conductivities may be very nearly the same. When the metallic ore is disseminated in the surrounding medium there is only a moderate local increase of the conductivity, and yet the resistivity method can be successfully used. The applicability of the method can be decided on the basis of mineralogy of the ore body being investigated.—*S. T. V.*

168–83. Urazayev, I. M. O prirode yestestvennykh elektricheskikh poley, voznikayushchikh nad sul'fidnymi mestorozhdeniyami [The nature of spontaneous electric fields originating over sulfide ore deposits]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 9, p. 1054–1067, 1956.

Measurements of the natural potential over different ore deposits indicate that the negative potential of the oxidizing-reducing chains is conditioned by the presence of iron sulfides, and the positive potential of the concentration chains can be produced by the sulfides of zinc, iron, lead, and other metals. The intensity of the potential of the oxidizing-reducing chains is greater than that of the concentration chains. Thus polymetallic ore bodies are characterized by positives anomalies of relatively high intensity. Over an ore body with a low content of pyrite an anomaly of +15 mv was observed, whereas within the same ore zone an anomaly of −80 mv was measured over purely pyritic portions. Thus for a certain ratio of sulfides of iron and of other metals, no anomalous effect can be measured. Positive potentials are more quickly produced if the sulfides are in silicate formations rather than in carbonate formations.

Negative potentials of the oxidizing-reducing chains; which occur only over iron sulfides, are of greater intensity in carbonate environments than in silicate environments.—*S. T. V.*

168–84. Bulashevich, Yu. P., and Zakharchenko, V. F. Potentsial yestetvenno polyarizovannykh tel ellipsoidal'noy formy [The potential of naturally polarized ellipsoidal bodies]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 10, p. 1174–1181, 1956.

The electrical field of space containing ore bodies of ellipsoidal shape can be determined by solving the Laplace equation when the electric conductivity of the disturbing body and of the enclosing medium is known. The boundary conditions correspond to the presence of a discontinuity of potential value on the surface of the disturbing body equal to the electromotive force of the polarization; the potential value outside the ellipsoid (φ_a) becomes equal to zero at infinity and that inside the ellipsoid (φ_i) becomes zero at the intersection of the coordinate axes, making it possible to find solutions for φ_a and φ_i. From the general case, special values are readily found for a very oblate ellipsoid, corresponding to a disc-shaped ore body, for an inclined body. The inverse problem can be solved in only a few special cases.—*S. T. V.*

168–85. Ohashi, Syuji [Shuji]. On the SP phenomena at ore deposits and their surrounding layers [in Japanese with English abstract]: Mining Inst. Japan Jour., v. 72, no. 819, p. 5–11, 1956.

Self-potential values over ore deposits decrease (negative center), increase (positive center), or are discontinuous. From detailed study it is concluded that there are two elements to be considered: the existence of the self-potential current, referred to as the "dynamic or ohmic potential" which forms the main part of the self-potential reading, and the existence of the transition layer around the ore body, which provides the remaining part of the self-potential reading and which is referred to as the "static potential." Either can exist singly although usually they are superposed.—*V. S. N.*

168–86. Chetayev, D. N. K raschetu neustanovivshikhsya elektromagnitnykh poley v neodnorodnykh sredakh [On the determination of transient electromagnetic fields in heterogeneous media]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 32 (159), p. 3–25, 1956.

The building up of electromagnetic field in a two-layer medium when the field is excited by an element carrying direct current is analyzed for the two cases in which the electrical conductivities of the two layers are almost the same and in which the conductivity of the lower layer is very small.

When the electrode spacing is sufficiently great, the building up of the field can go on for several seconds. Observation of this phenomenon by using instruments without inertia can give additional information on the properties of the electric profile and makes the study of the building up of the current an important problem in geoelectric exploration. Using the method of A. V. Tikhonov (see Geophys. Abs. 142–12271), a solution is obtained of the Maxwell equations governing the process with the boundary conditions that the vectors H and the components E_x and E_y are continuous on the boundary surfaces of the strata, and the electromagnetic field at the beginning is zero.

The formulas obtained are quite cumbersome, even after some suggested simplifications. The solutions are also given as graphs of the vector E_x as a function

of the conductivity of the lower layer and as a function of the thickness of the upper layer.—*S. T. V.*

168–87. Ivanov, A. G. Izucheniye fazovoy struktury elektromagnitnykh poley pri elektrorazvedke [Study of the phase structure of electromagnetic fields in electrical exploration] : Akad. Nauk SSSR Doklady, tom 110, no. 5, p. 772–775, 1956.

In electrical surveys it is customary to define the intensity of an anomaly as $(A_x - A_n)/A_n$ where A_x is the amplitude measured over the disturbing body and A_n is the amplitude of the normal field. In reality the observed field values must be considered as the vectorial sum of the components of the normal and the anomalous fields which may be of different phases. The error can often be as much as 50–60 percent. An arrangement that includes, in addition to the main loop through which alternating current is pulsating, two additional phase compensators that produce vectorial addition or subtraction of the components of the field has been successfully used since 1946 in exploration for metallic ores in many parts of the *U.S.S.R.*—*S.T.V.*

168–88. D'yakonov, B. P. Printsipy ispol'zovaniya amplitudnofazovykh kharacteristik elektromagnitnogo polya v elektrorazvedke [Principles of the use of the amplitude and phase characteristics of the electromagnetic field in electrical exploration] : Akad. Nauk Izv. Ser. geofiz., no. 10, p. 1207–1210, 1956.

Curves representing the point-to-point variation of the amplitude and the phase angle for different frequencies have certain advantages when the electromagnetic field is produced by a long, theoretically infinite, cable fed by current at one end. In this case the electromagnetic field is described by only two magnetic components, H_z and H_x, and one electric component, E_y. The ratios, H_z/E_y, H_x/E_y, and H_x/H_z, of the magnetic and electric vectors of the Maxwell equation are determined. Heterogeneities extending in the direction of the cable do not produce any essential modification in the structure of the field. Thus the suggested determinations fully characterize the field with the least number of measurements. The compensation method, which is independent of the variations of the intensity of the feeding source, can be used in this procedure.—*S. T. V.*

168–89. Pavinskiy, P. P., and Kozulin, Yu. N. Pole vertikal'nogo magnitnogo dipolya nad dvukhsloynoy sredoy [The field of a vertical magnetic dipole over a two-layer medium] : Leningrad Univ. Uchenyye Zapiski, no 210, p. 134–157, 1956.

In this study a method is discussed of computing the electromagnetic field produced by a vertical magnetic dipole placed on the surface of a two-layer ground and oscillating with a given freqeuncy ω. A general solution of the problem is given with a detailed analysis of the cases in which the lower layer has infinitely high electrical conductivity or zero conductivity. The procedure is also shown for determining the field for any ratio of the conductivities of the two layers. The final results are presented in the form of series of special functions of two complex variables.—*Author's summary, S. T. V.*

168–90. Nikitina, V. N. Ob anomaliyakh peremennykh elektromagnitnykh poley nad tsilindricheskimi neodnorodnostyami [The anomalies of alternating electromagnetic fields over cylindrical heterogeneities] : Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 32 (159), p. 62–93, 1956.

A solution is obtained for the two-dimensional problem of the diffraction of the alternating electromagnetic field produced by the presence of a cylindrical inclusion of good electrical conductivity embedded in semispace (the ground) which is also conductive. The vectorial potential of the anomaly is represented as the source function, using the method of the distribution of linear induced currents. The boundary conditions represent the relation between the tangential components of the electrical and the magnetic vectors on the separating boundary surface. The problem is reduced to the solution of the integral equation. As an example, the analytic solution is given of the problem of the disturbing effect of an inclined layer in a homogeneous field. It makes possible the location of the layer; that is, of its depth and of the dip angle. Formulas given for the earth's surface make it possible to see clearly the effect of the frequency ω and of the electrical conductivity of the enclosing formations on the relative intensity of the anomalies E_{xa}, H_{ya}, and H_{za}. The distribution of the induced currents along the layer is also given for the case when this induction is caused by incoming plane wave. This result presents satisfactory reason for the replacement of the body under exploration by a single linear current flowing under the ground, a procedure often resorted to in practical cases.—*Author's summary, S. T. V.*

168–91. Luk'yanov, A. V. Modelirovaniye peremennykh elektromagnitnykh poley [Model studies of alternating electromagnetic fields]; Akad. Nauk SSSR Izv. Ser. geofiz., no. 8, p. 948–957, 1956.

The general criteria of the similarity of electromagnetic phenomena can be derived from Maxwell's equations and can be represented in the general case by two relations between the physical parameters that are to be satisfied. Under ordinary field conditions and for sinusoidal variations of the electromagnetic field, only one equation must be considered: $\sigma\mu w l^2$=const (where σ is the electrical conductivity of the medium, μ is the magnetic permeability, w is the circular frequency, and l is a measure of the linear dimensions). Experiments were conducted using water in a concrete tank as the medium in which the electromagnetic field was produced. The conductivity of water was adjusted by dissolving in it an appropriate amount of NaCl. The electromagnetic field was produced by a rectangular loop through which alternating current of a desired frequency pulsated. A conductive layer at a certain depth underground was imitated by a plate of duralumin placed in the tank. Other problems can be treated by selecting the parameters of different physical quantities in accordance with the equation given. The model results can be compared for simple problems with calculated results. Errors are estimated to be within 2 to 5 percent.—*S. T. V.*

168–92. Bhattacharyya, Bimal Krishna. Propagation of transient electromagnetic waves in a medium of finite conductivity: Geophysics, v. 22, no. 1, p. 75–88, 1957.

Transient electric and magnetic fields have been calculated for ramp function and sawtooth current sources immersed in a semiconducting medium. An electric dipole source has been assumed. In the case of ramp function input, it is observed that the peaks of the overshoots in the Θ-component of the electric field decrease in magnitude with the increase in rise time of the input pulse. It has also been shown that the rise time of the current pulses has definite effect upon the rise time and amplitude of the electric fields and that the sawtooth exciting pulses having large values of rise time may be conveniently used

to obtain measureable values of the electric and magnetic fields.—*Author's abstract*

168–93. Migaux, Léon, and Kunetz, Géza. Apports des méthodes électriques de surface à la prospection pétrolière [Contribution of surface electrical methods to petroleum prospecting (with discussion)]: World Petroleum Cong., 4th sess., Rome, Proc., sec. 1, p. 545–574, 1955.

In experienced hands, electrical surface survey methods (telluric surveys and depth profiling) offer certain advantages over seismic and gravity methods and should be used far more widely to complement them. This thesis is supported by a number of examples from Gabon, French Equatorial Africa; Alsace and Bresse, France; the Hodna Basin, Algeria; Madagascar; the Rharb, Morocco; and Sicily.—*D. B. V.*

168–94. Breusse, J. J. Recherche des gisement de pyrite par prospection électrique [Exploration of pyrite bodies by electrical prospecting]: Rev. Industrie Minérale, Recherche minière, special no. 1 R, p. 225–232, 1956.

Electrical prospecting methods have been used in exploration for pyrite in the Roches-Gagneaux, east-central France. The mineralized area was first localized by the self-potential method. A resistivity survey determined the most conductive zone in the mineralized area, indicating a large pyrite mass. To determine its extent and depth, a boring was made at an angle of 60° to a depth of 136 m. To find the horizontal extent, the ore body was connected to a source of current and the circuit closed through the ground at another very distant point (for all practical purposes infinity). The ohmic drop in current is extremely small in the mineral body and occurs almost entirely in the surrounding rocks so that the equipotential area traced on the surface shows the horizontal projection of the ore body. Borings made near the ends of the projection confirmed the electrical data.—*B. T. E.*

168–95. Shibatō, Kihei. Study of spontaneous polarization for the veins at Nishimurayama-gun, Yamagata Prefecture [in Japanese with English summary]: Geol. Survey Japan Bull., v. 7, no. 2, p. 35–42, 1956.

Study of spontaneous polarization over veins and vein zones in Nishimurayama district indicates that the negative potential has been influenced by changes in the topography developed on the highly resistant, silicified and pyritized rocks and by the difference in mineral combinations in the surface ore veins.—*V. S. N.*

168–96. Schmidt, Gerhard. Eigenpotential-Messungen unter Tage auf Siegerländer Spateisenstein-Gruben [Self-potential measurements underground at the Siegerland siderite mines]: Geol. Jahrb., Band 71, p. 675–679, 1956.

Underground self-potential measurements in the Siegerland siderite mines in Germany show that the size of the anomalies, which may be very large, depends more on the thickness of a vein than on its composition. Measurements were made along the workings and in exploratory boreholes. The reproducibility of the borehole measurements was excellent. The self-potential method may prove to be useful in ore mining, but further tests are necessary to clarify the origin of self-potential anomalies.—*D. B. V.*

Murozumi, Masayoshi, and Saitō, Tomosaburō. Geological prospecting at Kitatoyotsu District, Hokkaidō.—See Geophys. Abs. 168–252.

168–97. Dyke, L. J. An electrical resistivity survey in north-west Ankole: Uganda Protectorate Geol. Survey Dept. Records, 1954, p. 61–69, 1956.

A resistivity survey was made in the Lake George region, where large-scale sugar planting was being considered, to determine the possibility of obtaining water for irrigation from boreholes and the rate at which irrigation water would be able to drain away. Results were interpreted in the light of data from two boreholes; alternation of beds of coarse- and fine-grained sediments suggests that minor features in the resistivty curves may be due to vertical changes in resistivity.—*M. C. R.*

Lehmann, Martin. Geomagnetic and geoelectric investigation on lamprophyre dikes in the Lausitz massif.—See Geophys. Abs. 168–251.

168–98. Reussner, Alain; Caire, André; Glangeaud, Louis; Goguel, Jean; Guillaume, Marcel; Mautort, Jacques de; Munck, Fernand; Perrenoud, Marie-Jean; Ricour, Jean; and Stanudin, Boris. Trois exemples de reconnaissance hydrogéologique d'alluvions dans le département du Jura [Three examples of hydrogeological surveys of alluvium in the department of Jura]: Soc. géol. France Bull., 6e sér. tome 6, fasc. 4–5, p. 501–530, 1956.

The results of electrical resistivity measurements, used in conjunction with ground water surveys in the Jura department, France, were confirmed by drilling at Orgelet and Clairvaux. Good wells were located at Orgelet on the basis of the combined data; at Clairvaux, the electrical results showed that apparently favorable geologic conditions were actually unproductive. In a third area, at Tavaux, the geophysical results did not agree so well with the geology. A thin, very resistent bed between two highly conducting layers was not distinguished. Further complication was introduced by the fact that the mineral content of the water lowered the resistivity of certain layers.—*D. B. V.*

168–99. Glangeaud, Louis; Pézard, Robert; François, Solange; Perrenoud, Marie-Jean; and Toitot, Michel. Les nappes phréatiques et artésiennes du Jura septentrional (dept du Doubs). Leurs relations avec les réseaux karstiques [The phreatic and artesian ground waters of the northern Jura, Doubs. Their relations to the karst system]: Soc. géol. France Bull., 6e sér. tome 6, fasc. 4–5, p. 531–546, 1956.

Electrical and seismic methods are mentioned as having been used with geologic surveys and drilling in the exploration and exploitation of ground water in the northern Jura, France. By means of these geophysical methods, the thickness of alluvium could be determined more accurately, and faults in the karst formations, which serve as channels of circulation, could be traced. The major part of the report is on the geology of the area.—*D. B. V.*

168–100. Fritsch, Volker. Zur geoelektrischen Untersuchung der Zementverpressung von Staumauern und Staudammen [On the geoelectrical investigation of the cement injection of dam walls and reservoirs]: Geofisica Pura e Appl., v. 34, p. 79–100, 1956.

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A discussion of the theory, application, and results of a geoelectric method for controlling cement injections in rocks, on the basis of successful use in building sites in Kaprum, Austria, an area where rock is relatively dense, and in the karst region at Cetina, Yugoslavia. (See also Geophys. Abs. 165–128).—*B. T. E.*

ELECTRICAL LOGGING

168–101. de Witte, Leendert, Fournier, Kenneth P., and Tejada-Flores, Hernan. Calculation of guard electrode response curves: Geophysics, v. 22, no. 1, p. 677–74, 1957.

In the existing theories of guard electrode logging, the electrode is approximated by a prolate spheroid. All equipotential surfaces are assumed to be concentric prolate spheroids and the current nappes are bounded by hyperboloids. This picture ignores the refraction of current at the foreface and at the boundary of invaded zones of porous formations.

A new approach to guard electrode theory has been formulated in which the electrode is represented by a series of spheres having the same diameter as the electrode. The boreface and invaded zone boundary are considered to be cylindrical. The current from each sphere is calculated from the condition that all spheres must be at the same potential and the potential distribution is found by superposition of the fields due to the individual currents.

For small drill holes in otherwise homogeneous formations of moderate resistivity the prolate spheroid approximation gives results that are identical with those of the present theory. For larger holes, invaded formations and large resistivity contrasts, the prolate spheroid method is shown to give varying degrees of error in the calculated apparent resitivities.—*Authors' abstract*

168–102. Blum, Eugen. Fundamentale Probleme bei der quantitative Auswertung elektrischer Bohrlochdiagramme [Fundamental problems in the quantitative evaluation of electric logging diagrams]: Erdöl u. Kohle, Jahrg. 9, Heft 12, p. 834–836, 1956.

Determination of the true resistivity R_t of a rock from a single measurement, for example with the Laterolog or Focuslog, is extremely questionable because either the resistivity R_i of the infiltrated zone is not negligible in comparison to R_t, or the extent d_i of this zone has a considerable magnitude, or both. If one bears in mind that d_i must have a definite minimum value, it seems necessary, in order to obtain a usable value of R_t for the calculation of the formation resistivity factor F, to determine the diameter d_i and the resistivity R_i of the infiltrated zone quantitatively to be able to apply necessary corrections.

A determination of R_t consists therefore of 3 measurements which must be carried out with measuring apparatus of different penetrating depths and different kinds of current flow in the borehole. Such instruments are available. The foundations for quantitative evaluation of the measurements undertaken with such apparatus, however, are not yet adequate.

Problems similar to those in the determination of R_t also occur in the determination of R_i alone.—*Author's summary, D. B. V.*

168–103. Eydman, I. Ye. Ob elektrokarottazhnykh parametrakh [The parameters of electric well logging]: Prikladnaya geofiz., vypusk 14, p. 156–188, 1956.

A discussion of the interpretation of the spontaneous polarization (self-potential) curve in well logging. The properties of the double electric layer

as influenced by the physicochemical characteristics of the mud and the walls of the well, relations between the lithologic factors, especially the pore geometry of the surrounding formations, and the measured *SP* value, and the effect of the chemical composition of the water and its mineral content and temperature on the *SP* value are considered. An experimentally determined parameter is introduced to characterize the pore structure of the formations and their physicochemical properties.—*S. T. V.*

168–104. Hiller, Robert E. How to log gas-drilled holes: Oil and Gas Jour., v. 54, no. 80, p. 190–191, 1956.

In holes drilled with gas, conventional electric logs and MicroLogs cannot be used. In such holes the gamma ray, induction, and temperature log combination provides adequate information as to lithology, fluid content, and gas entries. Examples from the San Juan basin illustrate the technique.—*D. R. M.*

168–105. Rosoff, C. Étude géophysique des sondages de recherche d'eau et d'exploitation minière [Geophysical well-logging in exploration for water and mineral exploitation]: Rev. Industrie Minérale, Recherche minière, special no. 1 R, p. 233–261, 1956.

A review of the well-logging methods and their application in exploration for aquifers of potash, lignite, and coal; and an evaluation of their future use in exploration of other minerals.—*B. T. E.*

168–106. Fedynsk[i]y, V. V., and Komarov, S. G. Geophysical investigation of drill holes in USSR: World Petroleum Cong., 4th sess., Rome, Proc., sec. 1, p. 747–758, 1955.

A review of electrical and radioactive logging techniques. Electrical logging has been used in Russia since 1929, radioactive methods have been used for the past few years. In 1954, 25,000 km of drill hole were logged electrically, 3,500 km by radioactivity.—*D. B. V.*

168–107. Schaub, Heribert, and Jessen, Werner. Ein praktischer Fall guter Übereinstimmung von geologischer Feinaufnahme mit elektrischen Bohrlochmessungen im Steinkohlengebirge [A practical case of good correspondence of detailed geological records with electric log measurements in coal formations]: Geol. Jahrb., Band 71, p. 381–384, 1955 (1956).

Almost complete core recovery in an exploratory boring penetrating 692 m of coal-bearing strata in the Lower Rhine coal basin, Germany, permits direct comparison of the lithologic details with logging data. Electrical resistivity and self-potential and gamma ray logs were made without reference to the core, yet correspondence is very good. Coal seams were located within a few decimeters. In some places discrepancies of 10–20 cm in the thickness of beds could be attributed to incomplete core recovery. A 40-cm band of clay ironstone at 608.5 m depth was clearly differentiated in the electric logs. It is concluded that the lithology of a borehole can be reconstructed solely from logging data.—*D. B. V.*

ELECTRICAL PROPERTIES

168–108. Komarov, S. G. Opredeleniye poristosti porod po udel'nomu soprotivleniyu [Determination of the porosity of rocks by their specific resistivity]: Prikladnaya geofiz., vypusk 14, p. 129–155, 1956.

A discussion of the use of micrologging to determine the porosity of permeable formations in drill holes. Graphs and tables of experimental data obtained on sand, sandstone, siltstone, and carbonate are included. Possible errors in the determination of porosity from the specific resistivity of the formation are evaluated for different experimental conditions.—*S. T. V.*

168–109. Burr, H. S. Effect of a severe storm on electric properties of a tree and the earth: Science, v. 124, no. 3233, p. 1204–1205, 1956

Simultaneous records of potential in a tree and in the earth showed an oscillation of the standing potential in the earth for several hours preceding a severe storm, a sudden reversal of polarity in both the earth and the tree as the storm passed, and then a return to previous conditions.—*M. C. R.*

168–110. Takenaka, Syunzo. On the relation between electric properties of pyrrhotite and ore deposits: 1. Variation in the electric resistivity of pyrrhotite with ore deposits [in Japanese with English summary]: Mining Inst. Japan Jour., v. 72, no. 818, p. 431–437, 1956.

The frequency curve of measurements of the resistivity of pyrrhotite from pyrometasomatic deposits has two peaks and from hydrothermal deposits, one peak. The resistivity of pyrrhotite in skarn of high-temperature origin is higher than that of pyrrhotite in low-temperature deposits, and there is no correlation between resistivity and difference of elevation within a deposit. There is some qualitative relationship beween types of frequency curves and temperatures at which the pyrrhotite was deposited, and this relationship may be applied to geothermometry.—*V. S. N.*

EXPLORATION SUMMARIES AND STATISTICS

168–111. Lauterbach, Robert. Angewandte Geophysik in Erkundung und Kartierung [Applied geophysics in exploration and mapping]: Zeitschr. angew. Geologie, Band 2, Heft 10, p. 443–445, 1956.

Geophysical procedures should be incorporated directly in geologic mapping programs, not merely used to provide material for comparison purposes. The possibilities being explored in Germany include micromagnetic (Geophys. Abs. 160–45, 46), geoelectric (Geophys. Abs. 166–156), and radioactive methods (Geophys. Abs. 160–167). Laboratory measurements of density and other physical properties also contribute to the usefulness of geophysics in mapping.—*D. B. V.*

168–112. Cortes, Henry C., and Gsell, Ronald N. Geophysical prospecting over continental shelves: World Petroleum Cong., 4th sess., Rome, Proc., sec. 1, p. 575–603, 1955.

A review of the development of methods of geophysical prospecting in open water. The principal methods, in order of increasing resolution and operating costs, have been the magnetic, gravimetric, and seismic. The last can be used as cheaply or more cheaply per linear mile on large open water areas than on land. Surveying methods include use of radar, continuous radio waves, and sonar. As of July 1954 there had been 39 discoveries off the Gulf Coast of Louisiana and Texas, where most offshore exploration has taken place. A bibliography of 74 items is included.—*D. B. V.*

168–113. Agnich, F. J. Exploration for reefs by geophysical methods: World Petroleum Cong., 4th sess., Rome, Proc., sec. 1, p. 619–634, 1955.

A review of geophysical methods of exploration for limestone reefs. Gravity and seismic refraction surveys can be successfully used if the reefs are shallow and if the density contrast or velocity difference is sufficiently great, but the reflection method is by far the most effective. The criteria for location of limestone reefs are: folding of beds above the reef as the result of differential compaction; appearance of a velocity high on reflection from beds beneath the reef; abnormal divergence between beds immediately above and below the reef; and absence or poor quality of reflections from within the reef. Discussion by A. H. Kleyn, G. Kunetz, S. Hammer, H. Closs, D. C. Skeels, and F. J. Agnich on p. 632–634.—*D. B. V.*

168–114. Skeels, D. C. Correlation of geological and geophysical data [with discussion]: World Petroleum Cong., 4th sess., Rome, Proc., sec. 1, p. 665–673, 1955.

Stresses "the need for a real fusion of geological and geophysical data and thought, to produce a better picture of geological conditions below the surface than can be obtained from either kind of data separately."—*D. B. V.*

168–115. Bentz, Alfred, and Closs, Hans. Developments in geophysical and geological exploration for oil in Germany, 1951–1954: World Petroleum Cong., 4th sess., Rome, Proc., sec. 1, p. 691–713, 1955.

A review of recent geophysical exploration in Germany and of the structure of the three principal oil provinces of Germany: northwestern Germany, the Rhine graben, and the Molasse trough. Cooperation between geophysics and geology is very close.—*D. B. V.*

168–116. Figueroa Huerta, Santos. Geophysical technique employed for petroleum exploration in Mexico during the last 15 years [with discussion]: World Petroleum Cong., 4th sess., Rome, Proc., sec. 1, p. 647–660, 1955.

A review of geophysical exploration for petroleum in Mexico between 1939 and 1954. Gravity, seismic, and, to a lesser extent, magnetic and electrical methods have been used. Gravity surveys cover 42,000 km^2 in the northeast zone, 48,000 km^2 in Tampico, 16,000 km^2 in Vera Cruz, 13,000 km^2 in the south zone (Tabasco and part of Campeche), 19,000 km^2 in Yucatan, and 12,000 km^2 in lower California. Seismic surveys have been made of 28,000 km^2 in the Northeast zone, 19,000 km^2 in Tampico, 3000 km^2 in Vera Cruz, and 19,000 km^2 (including 1,600 km^2 marine exploration) in the south zone. A total of 2,256 crew months of geophysical exploration is reported for 1939–54. Geophysical studies have participated in 39 discoveries, or 80 percent of the total.—*M. C. R.*

168–117. Krasulin, V. S. Soveshchaniye geofizikov Ministerstva geologii i okhrany nedr [The conference of the geophysicists of the Ministry of geology and conservation of natural resources]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 10, p. 1234–1236, 1956.

A review of the progress during the past 5 years by geophysicists in exploration for minerals. The greatest success was attained by use of gravimetric, magnetic, electric and seismic methods in addition to extensive geologic investigations. An example cited is the successful exploration for iron ore in the

region of Kursk-Belgorod, where the profile of the crystalline basement was determined by the "correlated method of refracted seismic waves"; individual formations were distinguished by detailed gravimetric and magnetic surveys; the thickness of the ferrous quartzites was determined by the magnetic method; and magnetite and martite deposits were delineated by gravimetric surveys. The results of the various geophysical surveys were checked step by step by drilling. Similar combined geophysical methods were used in exploration for coal, iron ore, and bauxite in the Ural mountains and for titanium ore in northern Russia with good results. In some areas aeromagnetic surveys are also made as part of the geophysical work.—*S. T. V.*

168–118. Fedynsk[i]y, V. V. Geophysical prospecting for oil and gas in the Soviet Union: World Petroleum Cong., 4th sess., Rome, Proc., sec. 1, p. 759–774, 1955.

A review of geophysical prospecting in the U. S. S. R., which began in 1925 with gravity surveys in the Ural-Emba salt dome regions, and at present includes regional surveys of promising areas (mainly by gravity and seismic methods), prospecting of structures for drilling (mainly by the reflection method alone or combined with other geophysical methods), and investigations in wells to study the sections and recognize productive horizons.—*D. B. V.*

168–119. Mirtsching, A. Entwicklung der Erdölschürfungen in der Sowjetunion in den Jahren 1950–1955 [Development of petroleum prospecting in the Soviet Union in the years 1950–1955]: Erdöl u. Kohle, Jahrg. 10, Heft 1, p. 28–29, 1957.

A review of exploration for petroleum in the U. S. S. R. in 1950–1955, based for the most part on papers in Neftyanoye Khozyaystvo. The use of geophysical methods increased sharply after 1950. Gravity and seismic methods, chiefly, gave satisfying results in the oilfields of the Caucasus, the Ukraine, and Kazakhstan (Emba), but were less successful in the Volga-Ural region. Geophysics is expected to play an even more important part in the future and special attention will be given to improvements in apparatus. The petroleum possibilities of the various parts of the Soviet Union are summarized. Geophysical surveys will be especially important in western Siberia, where preliminary surveys have resulted in discovery of a large gas deposit in the extreme north, near Berezov on the lower Ob.—*D. B. V.*

168–120. Eby, J. Brian. Salt dome interest centers on Gulf Coast: World Oil, v. 143, no. 5, p. 143–150, 1956.

A review of salt dome reservoirs of the world, with special emphasis on the gulf coast of the United States where geophysical exploration has led to the discovery of large oil reserves.—*L. C. P.*

168–121. Lauterbach, Robert. Geophysikalische Prospektionsverfahren zur Aufsuchung und Erschliessung von Nickellagerstätten [Geophysical prospecting methods in the exploration and exploitation of nickel deposits]: Zeitschr. angew. Geologie, Band 2, Heft 8/9, p. 382–395, 1956.

A review of geophysical investigations of the nickel deposits at Sudbury, Ontario; Šluknov, Czechoslovakia; Saxony, Germany; Zabdowice Slaşkie, Poland; and Chelan County, Wash. In the exploration and exploitation of

nickel, a combination of methods (particularly magnetic and electrical), with interpretation of the geophysical data in the light of the geology and petrography of the area, seems to give the best results.—*D. B. V.*

168–122. Closs, Hans. Aufgaben und Aussichten geophysikalischer Arbeiten unter Tage zur Aufsuchung von Spateisensteingängen [Problems and outlook of geophysical work underground in the search for siderite veins]: Geol. Jahrb., Band 71, p. 681–693, 1956.

The network of underground workings in the Siegerland siderite region in Germany affords an opportunity to evaluate all the common geophysical methods. Examples are given for the torsion balance, gravimetric, magnetic, electrical, geothermal, radioactive, and seismic reflection methods. As siderite ore differs from its surroundings only in its higher specific gravity, the gravity and seismic methods should prove most useful. The former can be used for determination of vein thickness at distances as great as 30 m. Underground seismic reflection surveying is being developed. An extensive theoretical investigation of the dependence of reflections from ore veins on thickness and dip is planned. It is hoped that reflections from veins and from faults may be distinguished. The immediate objective of the seismic investigations in Siegerland is the improvement of the quality of reflection onsets; the ultimate objective is the development of a routine underground reflection survey procedure.—*D. B. V.*

168–123. Thienhaus, Rolf. Aufgaben und Aussichten montangeologischer Untersuchungen im Siegerländer Spateisenteinbergbau [Problems and outlook of mining geological investigations in the Siegerland siderite workings]: Geol. Jahrb., Band 71, p. 645–666, 1956.

This paper is concerned mainly with the position of the veins and their probable extension. The necessity for intensive geologic-geophysical investigation in the Siegerland siderite deposits of Germany is emphasized. The joining of old workings is dictated by the complexity of the ore reserves, and new findings are essential to prolong the life of the district. (See also Geophys. Abs. 168–122.)—*D. B. V.*

168–124. Lenoble, André, and others. Prospection et recherche de l'uranium [Uranium prospecting and exploration]: Rev. Industrie Minérale, Recherche minière, special no. 1 R, p. 109–157, 1956.

A review of exploration for uranium in France as organized by the Commissariat à l'Énergie Atomique. Included are the personnel aspects as well as a detailed review of the scientific methods and instruments used from the first surface prospecting, through the successive stages of drilling, to the more precise determination of exploitability by preliminary mining work. Geochemical methods are discussed by R. Coulomb and M. Goldstein and geophysical methods, by C. R. Collin.—*B. T. E.*

168–125. Broding, R. A., and Rummerfield, Ben F. Petroleum exploration methods as applied to uranium exploration: Mines Mag., v. 46, no. 7, p. 14–24, 1956.

The personnel, concepts, instruments, techniques, and philosophies developed in petroleum exploration are adaptable to and useful in uranium exploration. Petroleum and uranium exploration can efficiently be combined in many areas of sedimentary rocks. In particular, gamma-ray and resistance logs, developed

for the petroleum industry, are extremely useful in uranium prospecting.—*L. C. P.*

168–126. Balsley, J[ames] R. Programme de prospection géophysique de l'U. S. Geological Survey [Geophysical exploration program of the U. S. Geological Survey]: Rev. Industrie Minérale, Recherche minière, special no. 1 R, p. 262–273, 1956.

A review of the current program of the Survey presented at the Congrès du Centenaire de la Société de l'Industrie Minérale in June 1955.—*B. T. E.*

168–127. Olson, Robert W. The technical-economic aspects of automatic data reduction: Geophys. Prosp., v. 4, no. 4, p. 335–347, 1956.

A discussion of machine processing of geophysical data, its economic advantage (by reducing routine work and freeing scientists for more creative work and by increasing the volume of work), and its utimate value in improving interpretation. Magnetic processing of seismic data is described in some detail.—*M. C. R.*

168–128. Morrisey, N[orman] S. Profitable geophysical case histories: Oil and Gas Jour., v. 54, no. 79, p. 97–110, 1956.

A tabulation, prepared from *Geophysical Case Histories*, volume 2, of the different types of oil traps that have been found by geophysical exploration.—*D. R. M.*

168–129. Tarbox, George E. Aerial geophysical prospecting: Mines Mag., v. 46, no. 9, p. 36–40, 1956.

A discussion of the use of the helicopter in geophysical prospecting, including airborne radiometric and magnetic surveys, and transporting men and equipment in gravity and seismic operations.—*L. C. P.*

GEODESY

168–130. Müller, Iván. Közepes nehézség értékek meghátarozása az ortométeres magasságok kiszámításához [Determination of mean gravity values for the computation of orthometric heights (with English summary)]: Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, kötet 5, szám 3, p. 21–36, 1956.

To supplement the methods of determining mean gravity G_i, used in computing orthometric heights in geodesy, that have been developed by Niethammer, Baeschlin, Helmert, Vignal, Ledersteger, Baranov, and Ramsayer, Müller proposes a method based on the equation

$G_i=(g_i+g^0{}_i)/2$, where g_i is the measured value at the point in question and $g^0{}_i=[\gamma_{i0}+\text{Bouguer anomaly}-(0.3086-0.0418\ \sigma_i)u_i-0.0418\ u_i z'_i]10^{-3}$ cm sec^{-2}.

u_i is the undulation of the geoid, σ_i is the local density in g per cm^3, and z'_i is rough height in meters. Of all methods, this most closely approaches the Niethammer orthometric heights, considered by far the best but not applied because of their complicated computations.—*D. B. V.*

GEOTECTONICS

168–131. Hiersemann, Lothar. Geologisch-geophysikalische Theorien über den Aufbau und die Dynamik der Erdkruste [Geological-geophysical theories on the structure and dynamics of the earth's crust]: Freiberger Forschunshefte, Geophysik, C 24, 154 p., 1956.

A summary of the most important geological, geophysical, and rheological observations concerning the structure and dynamics of the earth to a depth of 700 km and discussion of the more significant mountain-building hypotheses in the light of these known facts. It is concluded that the contraction theory and the convection-current concept together can explain the form of the earth's surface; episodic movements are related to contraction, and secular to convection. All hypotheses must remain speculative until more data on the rheological properties of the interior are available. A bibliography of 192 entries is included.—*D. B. V.*

168–132. Wilson, J. Tuzo. Origin of the earth's crust: Nature, v. 179, no. 4553, p. 228–230, 1957.

The Mohorovičić discontinuity corresponds to the early surface of the earth. The crust has been derived from the mantle by the extrusion of lava during geologic time at an average rate only a little greater than that estimated for the present time. Volcanism has been concentrated along fracture systems which have controlled the formation of the principal features of the crust. Two systems of fractures existed, a shallow stationary system along which basaltic lavas rise, and a deeper migratory system along which andesites rise. The sequence of events in mountain building is postulated as formation of an arcuate fracture and an island arc, formation of an active mountain arc by uplift and metamorphism, migration of active fracture to another place, and gradual erosion. Disturbance of the principal moments of inertia by the formation of mountain arcs may have caused polar wandering; stresses caused by distortion of the surface during polar migration would be concentrated on zones of weakness. Thus both the ice age and large transcurrent faults may be explained.—*M. C. R.*

168–133. Peyve, A. V. Svyaz' osadkonakopleníya, skladchatosti, magmatizma, i mineral'nikh mestorozhdeniy s glubinnymi razlomami. Glavneyshiye tipy glubinnykh razlomov. Stat 'ya 2 [Relation of sedimentation, folding, volcanism, and mineral deposits to deep fractures. Main types of deep fractures. Part 2]: Akad. Nauk SSSR Izv. Ser. geol., no. 3, p. 57–71, 1956.

The continuation of the review of deep fractures in the earth's crust (see Geophys. Abs. 167–118). Deep fractures produce contrasts in relief that cause changes in sedimentary facies; even when not directly expressed at the surface they may be reflected in sudden changes in the gradient of thickness within homogeneous sediments. Movement along deep fractures may be shown by increases in thickness, appearance of great masses of coarse sediments, and local unconformities. From these and also from the appearance of large amounts of material from deep in the earth (volcanism and ore deposition) such movements can be dated. Different types of magmatic activity are associated with different types of deep fractures and their surface expression. In old platforms, there is great diversity of extrusive and intrusive rocks, owing to differentiation, and

ultramafic, felsic, and highly alkaline types may all appear; young platforms are characterized by plateau basalts; the different stages of development of geosynclines are characterized not only by different igneous manifestations with their related types of ore deposits but also by various sediments derived from igneous rocks, such as graywacke. Folding is related to the mutual shifting of crustal blocks along the deep fractures; its extent depends on the magnitude of the displacement.—*D. B. V.*

168–134. Nature. Bombardment of the earth by meteors: Nature, v, 179, no. 4451, p. 121–124, 1957.

Report of a Geophysical Discussion of the Royal Astronomical Society. Papers by M. H. Hey and T. Gold presented differing views on the geologic importance of meteorites. J. G. Davies spoke on meteors. Gold suggests that craters formed by meteoritic impact in the early history of the earth may have caused a pattern of gravity anomalies or unbalance of the crust that influenced subsequent earth history and may now give rise to zones of instability, earthquake and volcanic regions, and other phenomena that tend to occur in arcuate patterns.—*M. C. R.*

168–135. Burwash, R. A. Reconnaissance of subsurface Precambrian of Alberta: Am. Assoc. Petroleum Geologists Bull., v. 41, no. 1, p. 70–103, 1957.

Recent drilling has shown that most of the Interior Plains of western Canada are underlain by rocks similar to those of the Canadian Shield. Petrographic study of samples from 100 wells and 18 potassium-argon age determinations indicate that the subsurface Precambrian of Alberta is divided into two areas; east of the boundary that extends from approximately lat. 60° N., long. 118° W., to lat. 52° N., long. 110° W., ages are of the order of 1,700 million years; west of the boundary ages are in the range of 1,200–1,500 million years. The eastern area may be an extension of the Churchill geologic province; the name Peace River is suggested for the western province.

On the basis of aeromagnetic maps of the south shore of Great Slave Lake, the major fault zone bounding the north side of Churchill province is extended beneath the Paleozoic sedimentary rocks of the Alberta shelf. Gravity data are still insufficient for any conclusive interpretation. The Peace River province seems to have an arcuate outline. This younger arcuate structure is taken as further support of the theory of continental growth by marginal accretion.—*B. T. E.*

168–136. Minato, Masao, Yagi, Kenzo; and Hunahashi, Mitsuo. Geotectonic synthesis of the green tuff regions in Japan: Tokyo Univ. Earthquake Research Inst. Bull., v. 34, pt. 3, p. 237–265, 1956.

Hokkaido includes three folded mountain arcs: the Yezo, Kuril, and Northern Honshu. The "green tuff regions" are the inner zones of the Kuril and Northern Honshu arcs. These inner zones were erosional areas during Paleogene and late Cretaceous periods, and suddenly became sedimentary areas and centers of igneous activity during the Neogene. The boundary between outer and inner zones is characterized by steep gravity gradients. Inner and outer zones have been subject to different movements; the relative movement has probably resulted in the formation of numerous faults parallel to the boundary. Igneous activity

in the faulted area was accompanied by the formation of a geosyncline. Subsequently the geosyncline became wider and deeper, synorogenic igneous activity resulted in the intrusion of granitic rocks, and finally the geosyncline began to rise. Transformation of the Yezo arc geosyncline to geanticline in the closing stage of the Cretaceous and formation of the mountain range in early Miocene, and the simultaneous subsidence of the Honshu and Kuril arcs, may have had some genetic connection with possible movement in the crust.—*M. C. R.*

168–137. Cotton, C. A. Geomechanics of New Zealand mountain-building: New Zealand Jour. Sci. Technology, sec. B, v. 38, no. 3, p. 187–200, 1956.

Many parts of New Zealand show the effects of superposed orogenies, the earlier Alpinotype, but the later necessarily Germanotype because of earlier cratonization of the terrain. A theory is suggested that the later orogeny, or block faulting, is the result of stresses set up by lateral drift along the "transcurrent fault zone" (a primary feature, a "geosuture" or "regmatic joint" according to the Cloos and Sonder terminology, respectively). If so, the Alpine Fault cannot have been produced by compression in the crust but must be a true tear fault caused by subcrustal movement. Other transcurrent faulting in New Zealand is probably of similar origin.—*D. B. V.*

GLACIERS

168–138. Nielsen, Lawrence E. Preliminary study on the regimen and movement of the Taku glacier, Alaska: Geol. Soc. America Bull., v. 68, no. 2, p. 171–180, 1957.

For an equilibrium glacier the quantity of ice transported across a given cross section at or below the firn line should equal the average quantity of ice melted or removed each year below the cross section and also the net yearly accumulation above the firn line minus the ice melted between the firn line and the given cross section. Measurements on three profiles on Taku glacier where the thickness had been seismically determined indicate the accumulation as measured by the snow cover is larger than the volumes calculated from either movement or ablation. Except near the terminus, the volumes derived from ablation data are larger than those determined from movement. The Taku glacier may therefore be approximately in equilibrium in the terminal region, but much more snow is accumulating in the upper regions of the glacier than is melting below the firn line.—*M. C. R.*

168–139. Ward, W. H. Glaciological studies in the Penny Highland Baffin Island 1953: Internat. Geod. Geophys. Union Assoc. Sci. Hydrology Pub. 39, tome 4, p. 297–308, 1954.

The velocity of ice flow on the Highway glacier of the Penny ice cap on the Baffin mountain range just north of the Arctic circle has been determined by the 1953 expedition of the Arctic Institute of North America to be 67 m per year for an area where the ice sheet is 1.7 km wide and, according to seismic measurements, as much as 270 m deep. Stake measurements were made during a period of 38 days and the velocity calculated is confirmed by an aerial photograph of 1948. The calculated mean shear stress on the bed is about 0.92 bars and the ice is evidently sliding on its bed.—*B. T. E.*

168–140. Heuberger, J. C. Mesures de temperatures dans l'ice-cap du Groenland [Thermal measurements in the Greenland ice-cap]: Geofisica Pura e Appl., v. 34, p. 71–73, 1956.

Thermal measurements taken in 1950 by the French polar expeditions in drill holes at Camp VI and the "Central Station" are not in agreement with those made by the Wegener expedition in 1930–31. Because variations in external temperature affect the composition of the névé to depths of 10–15 m, it is logical that within this depth a well of 1.50-m diameter would not give the same results as a borehole of 5-cm diameter. The results of the two expeditions are not necessarily contradictory, only incomparable. The fundamental hypotheses of Kurt Wegener based on the results of the two expeditions (see Geophys. Abs. 165–168) can only be verified by a borehole at least 500–1,000 m deep.—*B. T. E.*

168–141. Holtzscherer, Jean-Jacques. Contribution à la connaissance de l'inlandsis du Groenland. Première Partie: Mesures séismiques [Contribution to the knowledge of the Greenland Ice Cap. First part: Seismic measurements]: Internat. Geod. Geophys. Union Assoc. Sci. Hydrology Pub. 39, tome 4, p. 244–270, 1954.

Longitudinal wave velocities through the ice and the underlying bedrock were determined by seismic refraction surveys on the Greenland Ice Cap by the French polar expeditions. The average velocity through the ice was 3,800±30 m per sec. Velocities in the underlying bedrock indicate the existence of 3 different layers; the top 2 are metamorphic (gneiss) and approximately 1,000 m thick. The velocity through the deepest layer is of the order of 6,650±100 m per sec and may indicate basalt. The thickness of ice was determined by reflection shots; the greatest thickness is 3,410 m (at about 72° N and 36°–40° W). The approximate volume of the ice cap was calculated as 1.75×10^6 km^3; if the density is 0.9, the corresponding water volume is 2.43×10^6 km^3.—*B. T. E.*

168–142. Johnson, Arthur. Observations on the Nisqually glacier and other glaciers in the northwestern United States: Internat. Geod. Geophys. Union Assoc. Sci. Hydrology Pub. 39, tome 4, p. 511–516, 1954.

Rates of recession of the Nisqually glacier, Mount Rainier, Wash., since 1857 show that there has been a trend toward greater recession since the latter part of the 1890 decade. Change of surface elevation has been observed over a period of more than 20 years by measurement of several profiles; the data indicate that a wave, first apparent in 1945, has been moving down the higher parts of the glacier and may eventually result in an advance of the terminus. The maximum change in surface elevation was an increase of 200 ft in 7 years at the uppermost profile. In 1945, movement near the uppermost profile was 250 ft while at the second profile (3,500 ft downstream) the maximum movement was 60 ft. Observations on Coleman glacier, Mount Baker, Wash., indicate that a wave has been moving down this glacier also. Short summaries of the studies of other glaciers in the area are also included.—*B. T. E.*

GRAVITY

168–143. Hammer, Sigmund I. Modern methods of gravity and seismic interpretation: World Petroleum Cong., 4th sess., Rome, Proc., sec. 1, p. 635–646, 1955.

Modern gravity and seismic interpretation techniques show a definite trend toward more quantitative evaluation and utilization of data. Those in use and

under development—residual and second-derivative maps, resolution, continuation, statistics, and electronic computations—are reviewed and illustrated by selected maps and figures. Discussion by R. Brown, A. Schleusener, L. Migaux, and S. I. Hammer on p. 645–6.—*D. B. V.*

168–144. Woollard, G[eorge] P. Standardization of the world's gravity data: Am. Geophys. Union Trans., v. 37, no. 6, p. 669–675, 1956.

The problem of standardizing the world's gravity data is threefold: establishment of an accurate absolute-gravity reference datum; establishment of a gravity reference standard for evaluating the accuracy of relative gravity measurements; and establishment of an international network of stations. This paper is largely a review of the current status of investigations of each of these requirements, with emphasis on the programs carried out under the auspices of the Air Force Cambridge Research Center and the Office of Naval Research.—*M. C. R.*

168–145. Egyed, László. A regionális anomáliák elvi kérdéseiröl [Some notes concerning the principles of regional anomalies (with English summary)]: Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, kötet 5, szám 3, p. 3–8, 1956.

Residual anomaly is defined as the limiting value of the difference between the true and the mean regional value for a particular circle of land, described by the formula $R(g_o)=\lim_{r=0}(g_o-\bar{g})/\pi r^2$, where g_o is the anomaly at the center of the circle in question, $\bar{g}$ is the mean regional anomaly, and r is the radius. It is shown that this "radius of environment" has both an upper and lower limit which must be determined for the area investigated.—*D. B. V.*

168–146. Vyskočil, Vincenc. Určení rozhraní dvou prostředí přímým výpočtem z tíhových anomalií [Determination of the boundary between two media directly from gravitational anomalies]: Československé Akad. Věd. Geofys. Ústavu Práce, Geofys. Sborník, no. 21, p. 29–43, 1955.

Two different methods are given for determining the boundary between two media from gravity anomalies. The media in question are assumed to be of constant but different densities and to be free of disturbing bodies, so that the anomalies measured on the surface of the earth are caused only by the undulations of the boundary surface between them. One method is purely analytical, based on the solution of the Laplace equation by development of the gravity potential into the Fourier series; and the other, less precise, is based on the method of finite differences. For the first method, formulas are given in a form convenient for numerical computation and capable of being extended to three-dimensional problems.—*S. T. V.*

168–147. Kuzivanov, V. A. K voprosu o redutsirovanii anomaliy sily tyazhesti [On the reduction of gravity anomalies]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 10, p. 1161–1173, 1956.

A discussion of the reduction of observed gravity values determined at the earth's surface to a new chosen plane of spheroidal surface, a problem of special importance in surveying mountainous regions. The study is closely related to that of M. S. Molodenskiy on the external gravitational field and the shape of the earth's physical surface [See Geophys. Abs. 134–10228]. Molodenskiy's

formulas for the theoretical corrections are simplified, leading to approximate values of sufficient accuracy. Most of the paper is an explanation of the methods used in the numerical evaluation of the derived formulas.—*S. T. V.*

168–148. Kazinskiy, V. A. K osnovam teorii rudnichnoy gravimetrii [On the principles of the theory of mining gravimetry]: Akad. Nauk SSSR Doklady, tom 109, no. 6, p. 1126–1128, 1956.

Formulas are derived that can be helpful in computing corrections in gravimetric measurements over mining galleries or worked-out cavities.—*S. T. V.*

168–149. Bull, C., and Hardy, J. R. The determination of the thickness of a glacier from measurements of the value of gravity: Jour. Glaciology, v. 2, no. 20, p. 755–762, 1956.

On a Norwegian glacier gravity values were measured along four traverse lines and compared with values measured along three traverse lines in the valley below the glacier snout. After correcting for the altitudes of the stations and for the effect of the valley walls, the differences between the gravity values on the glacier and those in the valley below the glacier were attributed to the thickness of the glacier. Errors in the thickness so determined are estimated as within 20 percent on some sections and 40 percent on others.—*V. S. N.*

168–150. Clarkson, H. N., and LaCoste, L. J. B. Improvements in tidal gravity meters and their simultaneous comparison: Am. Geophys. Union Trans., v. 38, no. 1, p. 8–16, 1957.

Improvements in the photoelectric optical system and servosystem with a compensating network have overcome the major difficulties in the first tidal gravity meter (see Geophys. Abs. 166–205). Tests at Austin, Tex., with two meters recording simultaneously indicate that variations in gravity can be measured with less than 1 microgal error.—*M. C. R.*

168–151. Bulanzhe, Yu. D. Vliyaniye szhimayemosti kompensatsionnoy zhidkosti v kvartsevykh gravimetrakh s gorizontal 'noy krutil 'noy nit 'yu [The effect of the compressibility of the compensating fluid in quartz gravimeters with horizontal torsion string]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 9, p. 1114–1120, 1956.

Extensive theoretical calculations indicate that the compressibility of the compensating liquid can effect the indication of a Nørgaard gravimeter by as much as 7.0 milligals per bar change in barometric pressure. Experiments, however, show that the error is practically negligible. The discrepancy is believed to be due to the variation of the modulus of elasticity of fused quartz as a result of pressure on the compressed liquid. This variation, previously an unknown factor, is about -4.54×10^{-5} per bar change in pressure.—*S. T. V.*

168–152. Ochapovskiy, B. L. Gravimetricheskiy mayatnik maloy massy [Gravity pendulum of small mass]: Leningrad Univ. Uchenyye Zapiski, no. 210, p. 105–113, 1956.

A new gravity pendulum is suggested consisting of an elongated ring made of tape 10 mm wide and 5 mm thick, with a crossarm in its upper part to which knife edges are attached similar to those of chemical scales. The weight of the oscillating portion can be only 55–60 gr which is about 30 times less than in the usual instruments. Because the dimensions of the new pendulum are much

smaller, the errors due to temperature stratification will be much reduced. Some difficulty is expected in eliminating the error due to variation of the length of the pendulum. To attain an error of less than 1 milligal, the variation of the pendulum length must be not more than 0.004 micron. The suggested instrument has not yet been constructed.—*S. T. V.*

168–153. Lozinskaya, A. M., Tsimel'zon, I. O., and Laskina, V. V. Opyt regional'noy s'yemki na Kaspiyskom more s donnymi gravimetrami [Experiences with remotely operated marine gravimeters in a regional survey of the Caspian Sea]: Prikladnaya geofiz., vypusk 14, p. 115–128, 1956.

In 1954 a gravimetric survey was made in the region of Baku on the Caspian Sea, using an underwater remotely operated gravimeter of Russian construction. About 135 stations were occupied on 3,000 km of profiles across the Caspian Sea. The instrument used is a development of the GKA gravimeter in which visual observation of the angular deflection of the main arm of the instrument was replaced by a remotely determined and controlled linear displacement affecting a specially introduced electric microcapacitor. The gravimeter is enclosed in a strong hermetic housing in which the temperature was regulated and thermostatically controlled. The housing was connected with the surface boat by a four-conductor cable for operation of the gravimeter. Under favorable conditions, the error of an individual reading may be as small as ±0.5–0.7 milligal. The depth range of the gravimeter is about 200 m. The wiring diagram is given.—*S. T. V.*

168–154. Matsuda, Takeo, and Suda, Yoshiro. On the accuracy of the North American gravimeter AG–108 [in Japanese with English abstract]: Geol. Survey Japan Bull., v. 7, no. 3, p. 47–51, 1956.

A series of observations in Kanagawa Prefecture, Japan, indicate a probable error, caused by unfavorable conditions in Japan, of 10.05 milligals.—*V. S. N.*

168–155. Shurbet, G. Lynn, and Worzel, J. Lamar. Gravity observations at sea in USS *Conger*, Cruise III: Am. Geophys. Union Trans., v. 38, no. 1, p. 1–7, 1957.

Gravity observations were made with a Vening Meinesz pendulum apparatus along 2 profiles in the Bahama Islands, a profile between St. Thomas and St. Croix, Virgin Islands, and at about 50-mile intervals between San Juan, Puerto Rico, and New London, Conn. Principal facts, including free-air and simple Bouguer anomalies, are tabulated for the 60 stations. Free-air anomalies between the Puerto Rico Trench and the 1,000-fathom line south of New London are −10 to −50 milligals. If the standard oceanic crustal section of Worzel and Shurbet (see Geophys. Abs. 163–246) is accepted as a basis of computation, the anomalies can be explained by variations of the thickness of the sediment or crustal rocks of less than 1 km.—*M. C. R.*

168–156. Ivanhoe, L. F. A gravity maximum in the Great Valley of California due to the isostatic effect of the Sierra Nevada: Geophysics, v. 22, no. 1, p. 62–66, 1957.

A gravity maximum extends along the full length of the Great Valley of California. This feature is believed to represent the western limit of the gravity effect due to the adjustment of the Sierra Nevada isostatic block. Recognition

that such a maximum with a sedimentary basin may be due to isostasy rather than to shallow geologic features assists in the interpretation of gravity data.—*Author's abstract*

168–157. Miller, A. H., and Innes, M. J. S. Gravity in the Sudbury Basin and vicinity: Dominion Observatory Ottawa Pubs., v. 18, no. 2, p. 11–43, 1955.

The results of some 500 measurements of gravity over an area of about 2,000 square miles in the Sudbury district are presented. Although a more complete network of stations is desirable, the principal trends and major features of the gravity field are believed to have been established. It has been shown that most of these features are largely controlled by surface densities of the rock formations. The anomalies, for instance, are quite variable over the Killarney granites and gneisses and were found to be directly related to density changes within these masses. A gravity high that persists along the southern boundary of the basin is the most prominent feature of the anomaly pattern and is largely due to the noritic phase of the irruptive and to the Stobie formation. The steep gradient over the Mississagi quartzites is interpreted as reflecting a thinning of this formation to the north. Evaluation of the gravity data over the basin suggests that the structure of the Sudbury irruptive and overlying Whitewater sediments is similar to one deduced by Collins and Kindle from geological considerations. The measurements deny the existence of large underground channels near the center of the basin, but provide some support to the theory that the rise of the magma was controlled by faulting along the south side of the basin.—*Author's abstract*

168–158. Saxov, Svend [E.]. A gravity survey of the vicinity of Ottawa: Dominion Observatory Ottawa Pubs., v. 18, no. 11, p. 253–286, 1956.

A detailed gravity survey has been made of an area of about 400 square miles in the vicinity of Ottawa. Several observers, using five different gravimeters, contributed to the work. Calibration and comparison was established along a baseline from Prescott, Ontario, to Maniwaki, Quebec. Data are tabulated for 392 stations. Bouguer anomalies plotted on a geologic base map consist of two major parts: large-scale regional effects due to density changes in the underlying Precambrian rocks, and local effects (no greater than 6 milligals) due to variations in the thickness of Paleozoic rocks. Local anomalies are also associated with major normal faults in the area. Anomalies associated with strong magnetic highs in the aeromagnetic map of the area may indicate more mafic phases of the Precambrian gneisses underlying the sedimentary rocks.—***M. C. R.***

168–159. Dyer, W. B. In southwestern Ontario gravity survey pays its way: Oil and Gas Jour., v. 54, no. 62, p. 86–92, 1956.

A slightly abridged form of the paper "Gravity prospecting in southwestern Ontario" in *Canadian Oil and Gas Industries.* (See Geophys. Abs. 165–193.)—***B. T. E.***

168–160. Shurbet, G. Lynn, and Worzel, J. Lamar. Gravity measurements in Oriente Province, Cuba: Geol. Soc. America Bull., v. 68, no. 1, p. 119–124, 1957.

Gravity measurements were made at about 2-mile intervals from Guantanamo to Holguin via Santiago and Bayama; in addition a few measurements were

made between Guantanamo and Baracoa. Data are given for 94 stations. No correlation is observed between the simple Bouguer anomalies and surface geology. A gravity maximum in the Cauto Valley is attributed to an ultramafic body and a gravity high of +161 milligals near 20°N, 76°W to an intrusive body.—*M. C. R.*

168–161. Kneissl, Max. Der deutsche Anteil an der Europäischen Gravimeter-Eichlinie Hammerfest-Rom [The German part of the European gravimeter-standard line, Hammerfest-Rome]: Bayerische Akad. Wiss. Abh., Math.-Naturw. Kl., Heft 78, 23 p. and supplement, 1956.

The main pendulum stations of the European gravity network extending from Hammerfest, Norway, to Rome are linked by gravimetric lines which, for the calibration of gravimeters of small range, have been subdivided by interpolation of intermediate stations at intervals of about 20 km. The German portion follows highways from the Danish to the Austrian border for a total length of 1,290 km and is subdivided into 65 sections with an average gravity difference of 10 to 15 milligals (total gravity range along the whole German portion, 830 milligals). Descriptions are given of each subdivision, the data of 6 different surveys along the line from 1951 to 1955 are compiled, and a table of preliminary differences between the main pendulum stations and some of the intermediate points are tabulated. Reproductions of the individual data sheets from the German gravity archives are presented in the supplement.—*D. B. V.*

168–162. Szénás, György. Átalános tapasztalatok a geofizikai módszerek magyarországi alkalmazásáról [General experiences in the use of geophysical methods in Hungary (with English summary)]: Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, kötet 5, szám 3, p. 37–55, 1956.

An analysis of each of the main factors that limits or makes impossible geophysical exploration in Hungary (chiefly from the gravity or seismic viewpoint): the weathered layer, lenticular sedimentation, eroded basement surface, horizontal anisotropy, screen effects, structural disturbances, and multiple reflections.—*D. B. V.*

168–163. Morelli, C[arlo]. Underwater gravity survey in the Adriatic Sea: World Petroleum Cong., 4th sess., Rome, Proc., sec. 1, p. 661–664, 1955.

A review of the first-order gravity survey (1953 and 1954) in the Adriatic Sea north of Ancona. (See Geophys. Abs. 159–25 and 163–13.)—*D. B. V.*

168–164. Rocco, T. Comparative geological and geophysical study of the Po Basin [with discussion]: World Petroleum Cong., 4th sess., Rome, Proc., sec. 1, p. 675–690, 1955.

A review of geophysical work (gravity and seismic) in the Po Basin of Italy and a summary of the stratigraphy and structure as revealed by these surveys and by numerous wildcat wells. The information acquired is limited to the Quaternary and Neocene, as few wells penetrated into pre-Miocene beds and seismic data from the older formations is too scarce for correlation.—*D. B. V.*

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168–165. Tsuboi, Chuji; Jitsukawa, Akira; and Tajima, Hirokazu. Gravity survey along the lines of precise levels throughout Japan by means of a Worden gravimeter. Part 8. Kwantō district: Tokyo Univ. Earthquake Research Inst. Bull., supp., v. 4, pt. 7, p. 407–474, 1956.

The complete report, the preliminary version of which was published in the Proceedings of the Japan Academy (see Geophys. Abs. 158–31). A map on the scale of 1:500,000 showing Bouger anomalies based on the International formula, and station data and observations are included. The highest anomaly, on the Pacific coast of the northern part of the Ibaraki prefecture, previously given as +171 milligals, is now given as +160; the lowest, about 25 km southwest of Tokyo, previously given as −14 milligals, is now given as −30 milligals.—*B. T. E.*

168–166. Tsuboi, Chuji; Jitsukawa, Akira; and Tajima Hirokazu. Gravity survey along the lines of precise levels throughout Japan by means of a Worden gravimeter. Part 9. Kyūshū district: Tokyo Univ. Earthquake Research Inst. Bull., supp., v. 4, pt. 8, p. 475–552, 1956.

This is the complete report, the preliminary version of which was published in the Proceedings of the Japan Academy (see Geophys. Abs. 160–25). A map on the scale of 1:500,000, showing Bouguer anomalies based on the International formula, and station data and observations are included. The anomaly along the southeast coast previously given as −56 milligals, is now given as −72 milligals.—*M. C. R.*

168–167. Ogawa, Kenzō. Gravity survey in Gumma Prefecture [in Japanese with English summary]: Geol. Survey Japan Bull., v. 7, no. 3, p. 53–58, 1956.

One of a series of reports on surveys covering the Kwantō Plain. The Bouguer anomaly is more or less parallel to the Tone River. The lowest point is near the headwaters, and gravity increases away from the river to the east and south where Paleozoic rocks crop out.—*V. S. N.*

168–168. Ochapovskiy, B. L., Raspopov, O. M., and Sytinskiy, A. D. O vertikal' nom gradiente sily tyazhesti [On the vertical gradient of gravity]: Leningrad Univ. Uchenyye Zapiski, no. 210, p. 114–133, 1956.

In computing elevation corrections it is usually assumed that the normal vertical gravity gradient is constant and equal to +0.3086 milligal per meter. A more precise method, applicable in surveys of mountainous regions, is based on the assumption that the ridges or deep valleys have the approximate shape of triangular prisms with an angle at the base of 30° or more. In this manner reductions are computed for many ridges or valleys of the Caucasus Mountains from known values of gravity at the base and on the top.—*S. T. V.*

168–169. Johnson, J. Burlin, Jr., and Cook, Kenneth L. Regional gravity survey of parts of Tooele, Juab, and Millard Counties, Utah: Geophysics, v. 22, no. 1, p. 48–61, 1957.

In the summer of 1955 a regional gravity survey was made in parts of Tooele, Juab, and Millard Counties, Utah. A total of 455 gravity stations were occupied in an area of about 1,700 square miles. A Bouguer anomaly map was compiled with a contour interval of 2 milligals.

Steep gravity gradients indicate major Basin and Range fault zones along the eastern margin of the Cedar Mountains, the southwestern margin of Davis Mountain and its associated outcrops, the northeastern margins of Camels Back Ridge and Simpson Buttes, the eastern margin of Granite Mountain, and the northern margin of the Dugway Range. The principal trend of these fault zones is northwesterly; and they were instrumental in partly outlining several of the mountain ranges in the surveyed area. Great graben with probable vertical displacements of at least several thousand feet were found east of Granite Mountain and northeast of Camels Back Ridge. The highest gravity values, which lie just northwest of Granite Mountain, are about 40 milligals higher than the surrounding surveyed region. Gravity anomalies transecting the Dugway and Thomas Ranges probably indicate pre-Basin and Range faulting.—*Author's abstract*

168–170. Shurbet, G. Lynn, and Worzel, J. Lamar. Gravity anomalies and structure of the West Indies, Part III: Geol. Soc. America Bull., v. 68, no. 2, 263–266, 1957.

During April 1955, 26 new submarine pendulum observations were completed near Puerto Rico; 19 stations form 2 profiles across the Puerto Rico trench, and 7 stations were near the Virgin Islands. The small downward deflection of crustal rocks in the Puerto Rico Trench reported in Part II is confirmed. Some thickening of the crustal rock section under the trench from normal oceanic thickness is shown by C. B. Officer's seismic data and confirmed by gravity calculations.—*M. C. R.*

168–171. Prosen, D. O radovima koji su pretkhodili uspostavlańu gravimetriske mrezhe u FNR Jugoslaviji [Operations preceding establishment of the gravimetric network of the FNR Yugoslavia]: Beograd Tekh. Velika Škola, Zbornik radova geol. i rudarskog fakulteta, p. 237–248, 1953–54.

A Worden gravimeter was used to make a tie between the Paris (Orly) observatory and Beograd. Measurements were also made at intermediate stations at Frankfurt-am-Main and Darmstadt. The value of g at Beograd was determined as 980,607.69 milligals.—*S. T. V.*

168–172. Šumi, Franć. Analiza interpretacije gravimetriskih merenja primenjenih u istraživanju nafte [Interpretation of gravimetric measurements in exploration for oil]: Srbija Zavod geol. i geofiz. istraživanja Vesnik, tome 11, p. 373–395, 1954.

An analysis of gravity surveys in two potential oil regions of Yugoslavia, the Zetsko Pole and the Ulcinjsko Pole. Both gravimeter and torsion balance measurements were made and are presented as Bouguer anomalies which are discussed in detail in terms of geology.—*S. T. V.*

HEAT AND HEAT FLOW

168–173. Lebedev, V. I. O vozmozhnosti pogloshcheniya solnechnoy energii kristallicheskim veshchestvom zemli [On the possibility of absorption of solar energy by the crystalline material of the earth]: Akad. Nauk SSSR Izv. Ser. geol., no. 4, p. 50–74, 1954.

Some endogene processes may be maintained by energy accumulated diurnally by hypergene reactions (kaolinitization, for example) that store up enough

solar energy to raise the temperature of the crust. Such a relationship between exogene and endogene forces, hitherto regarded as completely independent, provides another source of energy more permanent than radioactivity and might explain the origin of magma chambers and such tectonic phenomena as microfolding in deep metamorphic zones.—*D. B. V.*

168–174. Lyubimova, E. A. Vliyaniye pereraspredeleniya radioaktivnykh istochnikov na termicheskuyu istoriyu zemli [The effect of redistribution of radioactive sources on the thermal history of the earth]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 10, p. 1145–1160, 1956.

The assumption of uniform distribution of radioactive elements is justified for the initial phase of the earth's history, from the beginning through the gradual concentration of protoplanetary dust particles. But after the phase of relatively high temperature followed by subsequent cooling and stratification, and the consequent concentration of radioactive elements in the upper layers of the earth, the distribution of thermal energy in the earth was modified. The nonhomogeneous equation of heat conductivity for this case can be solved using Green's function determined by the method of images. The results of the calculations show that the enrichment of the earth's crust with radioactive substances results in a relatively insignificant rise of the surface temperature and of the amount of the heat lost by the earth into surrounding space, as compared with the values previously determined for the uniformly distributed radioactive substances. Several graphs representing the distribution of the temperature in the earth at different times are given.—*S. T. V.*

168–175. Verhoogen, J[ohn]. Temperatures within the earth: p. 17–43 *in* Ahrens, L. H., Rankama, Kalervo, and Runcorn, S. K., Physics and chemistry of the earth, v. 1, New York, McGraw-Hill Book Co., 1956.

A review. A table, showing temperatures within the earth, estimated by various methods from 1915 to 1955, is included.—*M. C. R.*

168–176. Gilvarry, John J. Temperatures in the earth's interior: Nature, v. 178, no. 4544, p. 1249–1250, 1956.

The exponent in Simon's equation of fusion temperature can be related to the Grüneisen constant of the solid at fusion under zero pressure; temperatures in the core calculated using a Grüneisen constant of 0.92 for iron in evaluating the exponent are higher than those calculated by Simon and Bullard. A quartic polynomial can be derived for temperatures in the earth as a function of depth using four temperatures: Bullard's estimate of 800±200° K as the temperature at 35 km; Coster's and Hughes' determinations of 1,300° to 1,800° K as the temperatures at which silicates show the low resistivity for a depth of 600 to 900 km required by geomagnetic results; the temperature at the base of the mantle taken as the average of the fusion temperatures of the liquid core and the solid mantle; and the fusion temperature at the boundary of the inner core; and requiring that the gradient vanish at the center of the earth. Temperatures implied by this equation are close to those given by Daly for greater depths in the mantle and are consistent with solidification of the mantle from the base up; the mean temperature gradient for the outer core is close to the adiabatic gradient which follows from Birch's work.—*M. C. R.*

168–177. Preston, F. W. Thermal conductivity in the depths of the earth: Am. Jour. Sci., v. 254, no. 12, p. 754–757, 1956.

In the interior of the earth it is probable that radiative transmission rather than ordinary thermal conductivity becomes the dominant factor in heat transfer if temperatures are well above low red heat. The effect would be a reduction of temperature gradients and temperatures in the interior in comparison with estimates based on ordinary conductivity. The conductivity studies on which this idea is based were made in connection with radiative conductivity of industrial glasses; radiative conductivity varies with the absorption coefficient, which is largely a function of the iron oxide content. In the interior of the earth there is uncertainty as to the content and form of iron, and uncertainty as to the temperatures below the first few kilometers, so radiative conductivity may be limited. It is also possible that the shells of the earth are largely crystalline and the grain boundaries would tend to reduce the mean free path of radiation thus reducing the effective conductivity.—*V. S. N.*

168–178. Boldizsár, T. Terrestrial heat flow in Hungary: Geofiscia Pura e Appl., v. 34, p. 66–70, 1956.

Temperature measurements have been made in two deep shafts, 90 m apart, in the Liassic coal basin of Transdanubia. Temperatures in the downcast shaft range from 31.1° C at 473.4 m to 37.0° C at 580.0 m. Thermal conductivity, determined by the divided-bar method, ranged from 2.30×10^{-3} to 8.60×10^{-3} cal per cm sec ° C. The heat flow is calculated as 2.055×10^{-6} cal per cm^2 sec. Heat flow of 3.066×10^{6} cgs units has previously been reported for the upcast shaft. (See also Geophys. Abs. 166–238.)—*M. C. R.*

168–179. Singer, Irving A., and Brown, Robert M. The annual variations of sub-soil temperatures about a 600-foot circle: Am. Geophys. Union Trans., v. 37, no. 6, p. 743–748, 1956.

Measurements of subsoil temperatures at four places on a circle of 600-ft diameter showed that the difference in ground cover has an appreciable effect on the temperature. Standard thermal diffusion coefficients are too small to account for the observed range of annual temperatures.—*M. C. R.*

168–180. Conrad, V[ictor]. On thermal springs. A contribution to the knowledge of their nature: Archiv Meteorologie, Geophysik u. Bioklimatologie, Ser. A, Band 9, Heft 3, p. 371–405, 1956.

The temperature and discharge of 14 thermal springs at Badgastein (Hohe Tauern, Austrian Alps) were observed for a year; daily observations were made at 4 springs, weekly at 6, and once in 5 weeks at the others. A rapid rise of 1° C observed in the 10 springs, and a simultaneous decrease 12 days later, suggests they have a common source. (Discharge was unaffected during these temperature variations.) No seasonal effect could be detected. From analysis of the absolute and relative variations in temperature and discharge it is concluded that the water is mainly juvenile, perhaps with minor amounts of admixed atmospheric water.

Only 4 springs show a *real* annual variation of both temperature and discharge. Movement of the poles, with two periodic components that cause stresses in the crust, probably contributes to release of earthquakes; it is suggested that it might also influence the mechanics of springs. One of these components has a period of 12 months, the other 14. Further observations over several years

would be necessary to determine whether a 14-months' variation in temperature and discharge also exists; if so, the enigma of annual variation of springs would be solved to some extent.—*D. B. V.*

Heuberger, J. C. Thermal measurements in the Greenland ice-cap.—See Geophys. Abs. 168–140.

INTERNAL CONSTITUTION

168–181. Frölich, F[riedrich]. Zum Problem der Inhomogenität des Erdinnern (Welche Aussagen gestattet der gegenwärtige Forschungsstand hierzu?) [On the problem of the inhomogeneity of the earth's interior (What statements does the present state of research permit in this respect?)]: Geologie, Jahrg. 5, Heft 6, p. 462–482, 1956.

The effect of inhomogeneity of the earth's mantle on convection currents in the interior is investigated mathematically. Present information on the nature of the interior is not enough to allow clear and precise conclusions. More high-pressure experiments (to 10^6 bar), refinement of seismological observations, and better understanding of the westward drift of geomagnetic secular variations are needed.

Convection processes, estimated to take place at a rate of about 1 cm per yr, or about 3 Å per sec, must work along the gliding planes of the crystalline region of the mantle (in olivine, along the Mg-Fe intermediate layers) and therefore are controlled by the orientation of crystal boundaries. In the inhomogeneous outer mantle layers, and probably to some extent in deeper regions, there is also the limitation imposed by the distortion or destruction of crystal boundary zones due to the heterogeneous constituents. Convection would be hindered in a radial direction within the inhomogeneous zone; this conclusion agrees with those reached by Brooks from other considerations. If the inhomogeneity of the upper mantle is due to phase transformations rather than to differences in chemical composition, the gliding process would be even more limited, and orientation would take place only in the direction of the gliding planes of the altered structure; this conclusion corresponds with Verhoogen's results obtained from an entirely different point of view. A bibliography of 157 items is included.—*D. B. V.*

168–182. Bullen, K. E. Seismology and the earth's deep interior: Australian Jour. Sci., v. 19, no. 3, p. 99–100, 1956.

A review of present knowledge of the physical state of the earth's interior as deduced from seismological data.—*D. B. V.*

168–183. Bullen, K. E. Seismology and the broad structure of the earth's interior: p. 68–93 *in* Ahrens, L. H., Rankama, Kalervo, and Runcorn, S. K., Physics and chemistry of the earth, v. 1, New York, McGraw-Hill Book Co., 1956.

A review of the contributions of seismology to knowledge of the earth's interior during the past 20 years or so.—*M. C. R.*

168–184. Press, Frank. Rigidity of the earth's core: Science, v. 124, no. 3233, p. 1204, 1956.

The rigidity of the core can be determined from the amplitude ratio of twice-reflected shear waves (ScS_{II}) to once-reflected waves (ScS_{I}) under conditions of

near vertical incidence. The average amplitude ratio of five earthquakes observed at Huancayo is 0.3. The decrease in amplitude of ScS_{II} may be ascribed to absorption of shear waves in traversing the mantle and to loss on reflection from the core boundary. If the mantle is perfectly elastic (absorption coefficient is zero), the ratio of mantle to core density about 4/7, and the rigidity of the mantle 3×10^{12} dynes per cm^2, the maximum rigidity of the core indicated is about 10^{11} dynes per cm^2; with the average dissipation constant in the mantle, the rigidity is at least an order of magnitude smaller. The ratio of rigidity to incompressibility in the core is smaller than 10^{-3}, which indicates a state unlike that of a normal solid.—*M. C. R.*

168–185. Ringwood, A. E.; Vening Meinesz, F. A. The olivine-spinel transition in the earth's mantle: Nature, v. 178, no. 4545, p. 1303–1304, 1956.

The Jeffreys-Bernal hypothesis (that the so-called 20° discontinuity and the rapid increase in density between 400 and 900 km are caused by a pressure inversion in the olivine of the mantle) was investigated by a thermodynamic study of subsolidus phase equilibria in the pseudo-binary system Ni_2GeO_4–Mg_2SiO_4. A molar free energy of transition was calculated as 68,000±10,000 joules per mole. The transition involves an increase of density of 11±3 percent. Spinel becomes the stable form at a pressure corresponding to a depth of 520±180 km. The olivine-spinel transition can explain the variation with depth of density, elasticity, and electrical conductivity, and is consistent with the inference by Bullen and Birch that the transition takes place over a wide range of depths. Occurrence of the transition raises difficulties for the convection theory of orogenesis because of the liberation of the latent heat during the transition and difficulties in maintaining equilibrium, but strengthens the contraction theory because of the volume contraction of the transition. Vening Meinesz refers to his paper (see Geophys. Abs. 166–242) in which he proposed a similar phase transition on the basis of convection currents in the mantle.—*M. C. R.*

168–186. MacDonald, Gordon J. F. Quartz-coesite stability relations at high temperatures and pressures: Am. Jour. Sci., v. 254, no. 12, p. 713–721, 1956.

Coesite-quartz stability relations have been investigated using the "simple squeezer" high-pressure apparatus [see Griggs and Kennedy, Geophys. Abs. 168–305]. Samples of amorphous SiO_2 in the form of silic acid ($SiO_2.nH_2O$) were subjected to pressures up to 80,000 bars and temperatures from 400°–800°C. The equation of the curve separating the fields of quartz and coesite is $P=22.5T+9500$ where P is in bars and T is in degrees Centigrade with coesite stable in the high-pressure region. The only phases produced were quartz and coesite. The equilibrium curve plus estimated thermal gradient in the earth indicates that quartz should invert to coesite at a depth between 60 and 100 kilometers within the earth.

The entropy of coesite at 25°C and one bar is 8.6±0.7 cal/deg mole as determined by the equilibrium curve. The heat of transition of quartz to coesite is −225±150 cal/mole. The thermal data on coesite indicate that the approximate maximum depths within the earth at which fayalite and forsterite are stable relative to "FeO" and MgO plus coesite are 200 and 1100 km.—*Author's abstract*

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168–187. Bullen, K. E. The influence of temperature gradient and variation of composition in the mantle on the computation of density values in Earth Model A: Royal Astron. Soc. Monthly Notices, Geophys. supp., v. 7, no. 4, p. 214–217, 1956.

Birch has shown that a temperature gradient in excess of the adiabatic gradient by 1° per km would reduce the density gradient given by the equation used for Earth Model A (see Geophys. Abs. 88–3565, 103–5744, and 109–6514). Variation in chemical composition increases the gradient. It is shown also that because of the procedure used in computing Model A, the maximum error in density is only 0.079 per cm^3. Thus reasonable temperature deviations cannot be considered as serious sources of error in the density distribution of Model A.—*M. C. R.*

168–188. Robertson, Eugene, Birch, Francis, and MacDonald, G[ordon]. J. F. Experimental determination of jadeite stability relations to 25,000 bars: Am. Jour. Sci., v. 255, no. 2, p. 115–137, 1957.

The reaction albite+nepheline=2 jadeite has been studied experimentally at pressures between 10,000 and 25,000 kg per cm^2 and at temperatures between 600° and 1200° C. The equilibrium line for the reaction is represented by the equation $P=1{,}000+18.5T$, where P is the pressure in kg per cm^2 and T is the temperature in degrees centigrade. The intercept at $T=0°$ C is subject to an uncertainty of $\pm 1{,}000$ kg per cm^2 and the slope is subject to an uncertainty of ± 1 bar per deg. The experimental line is in reasonable agreement with the thermochemical data and jadeite crystallizes on the high-pressure side of this line from glass of jadeite composition or from an albite-nepheline mixture.

The importance of the results of these equilibrium studies is discussed in relation to the high-pressure breakdown of the feldspars and the possibility that the Mohorovičić discontinuity may be the boundary for such transformation. This study of jadeite equilibrium is a first step in the experimental investigation of the eclogite equilibrium. Further work must include at least lime and magnesia as additional components.—*V. S. N.*

Jobert, Georges. Effect of crustal structure on the deformations caused by ocean tides.—See Geophys. Abs. 168–54.

168–189. Michot, Paul. La géologie des zones profondes de l'écorce terrestre [The geology of the deep zones of the earth's crust]: Soc. géol. Belgique Bull., tome 80, no. 1–2, p. 19–59, 1956.

From the principle set forth by Michot that basic anatexis in the catazone, leuconoritic in character, leads to the formation of vast anorthositic regions in the deep parts of tectogenes, it follows that an anorthositic layer of planetary extent underlies the granitic layer of seismology, and is identical with the "basaltic" or intermediate layer. For the surface separating the two sialic layers the name "sical discontinuity" is proposed (from the silico-calco-aluminous nature of the lower layer). This discontinuity, essentially a "front" of anorthositization, lies about 20 km deep at the time of its genesis, but at the end of a geologic cycle the sical discontinuity belonging to that particular period occupies a new position that may vary in depth from 0 to about 20 km. As observed today, it is a polygenetic line or zone resulting from the superposition or juxtaposition of orogenies, in other words the outermost surface of all the anorthosite fronts that have existed since the origin of the continental masses. It is not the same therefore as the Mohorovičić discontinuity, whose position is related to the relief of existing continental masses.—*D. B. V.*

168–190. Jung, Karl. Über den Aufbau der Erdkruste [On the structure of the earth's crust] : Natur u. Volk, Band 86, Heft 6, p. 196–203; Heft 7, p. 242–251, 1956.

A review of present knowledge of the structure of the earth's crust, including discussions of the Pratt and Airy concepts of isostasy, layering according to seismological data, and island arcs (negative gravity anomalies, seismicity, and volcanism).—*D. B. V.*

168–191. Tsuboi, Chuji. Crustal structure in northern and middle California from gravity-pendulum data : Geol. Soc. America Bull., v. 67, no. 12, p. 1641–1646, 1956.

The variation in the thickness of the earth's crust along the composite east-west profile in northern and middle California has been investigated on the basis of pendulum gravity data published by J. A. Duerksen. The earth's crust is about 24 km thick beneath the California coast line, and the thickness increases inland until it is 50 km at a point 350 km from the coast line. It has been deduced also that the deposits in the Central Valley increase in density rapidly with depth so that at depths of a few kilometers there is no appreciable density contrast with the basement rocks.—*Author's abstract*

168–192. Press, Frank. Determination of crustal structure from phase velocity of Rayleigh waves. Part 1 : Southern California : Geol. Soc. America Bull., v. 67, no. 12, pt. 1, p. 1647–1658, 1956.

Local changes in crustal structure from variations of phase velocity of Rayleigh waves are deduced by utilizing the prolonged, sinusoidal trains of dispersed Rayleigh waves characteristic of long oceanic propagation paths. Crests and troughs of these waves can be traced across a triangular array of seismograph stations when the station separations are not more than a few wave lengths. Phase velocity and direction of approach can be determined for waves of a given period. By comparing observed phase velocity with an experimentally determined phase-velocity curve representative of the average continental crust, local crustal thickness is obtained.

Application of the method to Southern California indicates the following: (1) normal crustal thickness in the Peninsular Range Province; (2) increase of mean crustal thickness by about 50 percent in the Sierra Nevada block; (3) significant decrease in crustal thickness, possibly as much as 50 percent in the continental borderland.—*Author's abstract*

168–193. Bernard, Pierre. Interprétation des ondes séismiques des explosions des Rochilles (août-septembre 1956) [Interpretation of the seismic waves from the Rochilles explosions (August–September, 1956)] : Acad. Sci. Paris Comptes Rendus, tome 243, no. 25, p. 2115–2118, 1956.

The direct, reflected, transverse, Rayleigh, and air waves resulting from a series of explosions at Rochilles, France, were identified from seismic records obtained at four stations: Val-des-Prés, August 25; Allemont-en-Oisans, August 27; Villard-de-Lans, August 31 and September 4; and Vienne (Isère), September 6, 1956. Calculations of the depth of the Mohorovičić discontinuity using a velocity of 5.95 kmps range from 35.9 to 39.2 km. Transverse wave reflections indicate a depth of about 17.3 km for the Conrad discontinuity. On two of the days, with wind disturbance at a minimum, a direct wave apparently partly

aerial and partly seismic was observed, analogous to *T* waves at the ocean bottom.—*D. B. V.*

168–194. Mühlen, Walter von zur. Ergebnisse der "Steinbruch-Seismik" im Siegerland, Kraichgau und in Hessen Unterfranken [Results of "quarry seismics" in Siegerland, Kraichgau, and in Hessen, Unterfranken (Lower Franconia)]: Geol. Jahrb., Band 71, p. 569–594, 1956.

Refraction data have been obtained from several large quarry blasts (charges of 0.7 to 5 tons) at distances as great as 65 km by the Amt für Bodenforschung in Germany during 1950–54. These data show that the positive gravity anomaly of the Neckar-Tauber region is caused by the shallow depth of the intermediate layer in the Kraichgau area. In the Hessian Basin, the intermediate layer is at a depth of more than 7 km; the gravity anomalies must be related to the basement lying deep under post-Variscan sediments. In the Siegerland mining district, a high velocity (6.5 kmps) layer under the Devonian (5.0 kmps), attributed to the crystalline basement, may be the source of the hydrothermal siderite and sulfide deposits; magnetic measurements throw no further light on this interpretation.—*D. B. V.*

168–195. Gálfi, János, and Stegena, Lajos. Nagymélységü reflexiók Hajdúszoboszló videken [Deep reflections in the vicinity of Hajdúszoboszló]: Magyar Állami Eötvös Lórand Geofiz. Intézet Geofiz. Közlemények, kötet 4, szam 2, p. 37–40, 1955; Deep reflections in the environment of Hajdúszoboszló, north-eastern Hungary: Acta Geol. Acad. Sci. Hungaricae, tomus 4, fasc. 2, p. 229–233, 1956.

Deep structure in the Great Hungarian Plain was investigated by means of reflection measurements near Hajdúszoboszló, 20 km southwest of Debrecen. A charge of 437 kg of dynamite was exploded at a depth of 42 m; in the resulting seismogram a strong reflection appeared 8.6 sec after the reflection from the basement at 1.2 sec. Computations based on the mean velocity of 5.8 kmps for Europe, and taking into account the surface correction, indicate the depth of the reflecting surface is 22.7 km.—*D. B. V.*

168–196. Raitt, Russell W. Seismic refraction studies of the Pacific Ocean Basin. Part 1: Crustal thickness of the central equatorial Pacific: Geol. Soc. America Bull., v. 67, no. 12, pt. 1, p. 1623–1640, 1956.

Seismic refraction observations were made at 42 stations in the central Pacific within an area extending from latitudes 22° S to 28° N and longitudes 162° E to 112° W during the Mid-Pacific and Capricorn expeditions. Most traveltime data can be represented by three linear segments. The maximum apparent velocity was 8 kmps or more. The mean velocities observed were 5.38, 6.77, and 8.22 kmps in the Mid-Pacific expedition and 5.09, 6.76, and 8.25 kmps in the Capricorn expedition. The thickness of the crust (below which the velocity is 8 kmps) ranges from 4.8 to 13.0 km. At 7 stations near the western border of the region studied, the thickness is greater than 10 km. At the other 22 stations, the mean thickness is 6.3 km.—*M. C. R.*

168–197. Gamburtsev, G. A., and Veytsman, P. S. Sopostavleniye dannykh glubinnogo seysmicheskogo zondirovaniya o stroyenii zemnoy kory v rayone Severnogo Tyan'-Shanya s dannymi seysmologii i gravimetrii [Comparison of the data from deep seismic profiling on the struc-

ture of the earth's crust in the region of northern Tien Shan with the data of seismology and gravimetry] : Akad. Nauk SSSR Izv. Ser. geofiz., no. 9, p. 1036–1043, 1956.

Studies have been made of deep structure of the northern Tyan Shan Mountains by using geophone lines as long as 40 km. Gravimetric surveys of the same region have also been made and data on earthquakes collected. Comparison of the data obtained by the different geophysical methods indicates that deep geologic profiling gives reliable data on the regional structure and the physical properties of the deep layers and can be used to great advantage in seismotectonic studies. In the gravimetric surveys the possibility has been shown of establishing the effect of a deep basalt layer on the regional gravitational anomaly and by eliminating this effect to determine the local anomalies, important in prospecting for minerals.—*S. T. V.*

168–198. Gane, P. G., Atkins, A. R., Sellschop, J. P. F., and Seligman, P. Crustal structure in the Transvaal: Seismol. Soc. America Bull., v. 46, no. 4, p. 293–316, 1956.

Earth tremors in the Witwatersrand were recorded on profiles, west, south, east, and north by a triggering technique. The traveltimes, in seconds, are: P_n, $7.61+\Delta/8.27$; P_1, $0.24+\Delta/6.18$; S_n, $11.64+\Delta/4.73$; S_1, $0.37+\Delta/3.66$. The thickness of the crust is 35.1 km from P data, and 33.3 km from S data.—*M. C. R.*

ISOSTASY

168–199. Deicha, Georges. Aspects géotectoniques possibles de l'equilibre isostatique [Possible geotectonic aspects of isostatic equilibrium] : Soc. géol. France Bull., 6^e sér. tome 6, fasc. 1–3, p. 201–209, 1956.

The principle of isostasy is habitually illustrated by schemes which neglect the problem of stability of equilibrium within the elementary crustal units. Relative changes of level may occur, for instance, on opposite sides of an oblique fault traversing a mass of homogeneous density; vertical faults would of course not affect the equilibrium. Geotectonic theories should take into account this complementary aspect of isostasy.—*D. B. V.*

168–200. Hospers, J. Gravity and crustal shortening in the Alps: Geologie en Mijnbouw, jaarg. 19, no. 1, p. 1–18, 1957.

In general, about 10 percent overcompensation is indicated by the Bouguer and isostatic anomalies along a profile across the Alps approximately through Geneva and Mt. Blanc. Most of the residual negative isostatic anomalies are due to this overcompensation; locally there are fairly steep negative anomalies over the Hercynian massifs. The cross section of the root in this profile is about 1,400 km^2, for an assumed density contrast of 0.6. The positive isostatic anomaly (120 milligals) at the southern edge of the Alps is due to a heavy body, probably in floating equilibrium, approximating a horizontal cylinder 200 km long, between 180 and 360 km^2 in cross-sectional area (for a density contrast of 0.6), with its centerline 12.5 to 15 km below sea level; the Ivrea zone of basic and ultrabasic rocks is in this area. The negative isostatic anomaly of the Po valley cannot be accounted for by lighter sediments alone, but must involve crustal downwarping of 6 km or more.

The amount of crustal shortening estimated from the size of the root is at least 50 km; at most, 300 km. The latter is probably a gross overestimate.

Geologic estimates of at least 1½ times this maximum amount are difficult to reconcile with these figures. The gravity data lead to a picture of the crust in the Alps that is consistent with Vening Meinesz' theory of mountain building and also with van Bemmelen's. Gravity data alone cannot decide between the two theories unless quantitative checks are applied to the suggested mass distributions.—*D. B. V.*

ISOTOPE GEOLOGY

168–201. Gentner, W., and Zähringer, J. Argon und Helium als Kernreaktionsprodukte im Meteoriten [Argon and helium as nuclear reaction products in meteorites]: Geochim. et Cosmochim. Acta, v. 11, no. ½, p. 60–71, 1957.

Helium and argon isotope abundances were measured for 5 iron and 3 stony meteorites (He^3+He^4; He^3; $A^{36}/A^{38}/A^{40}$; A^{36}/A^{38} corrected to $A^{40}=1$; and A^{36}). The A^{36}/A^{38} abundance ratio averaged about 1.7, and there were 6.6 A^{38} atoms to every 100 He^3 atoms. The results can be explained by an evaporation process initiated by nuclear reactions from cosmic rays. Given the intensity and energy distribution of cosmic radiation in earlier times, the age of meteorites can be obtained from the amount of residual radioactive nuclei present, or, conversely, the cosmic ray intensity outside the earth, in former times, can be deduced from the residual radioactive nuclei. Studies along these lines have indicated that either the cosmic ray intensity was greater in former times (10^5 and 10^9 years ago, from the Cl^{36} and K^{40} nuclei, respectively), or it is much greater outside the earth than measured at the North Pole. As the activity of Cl^{36} is proportional to the intensity of cosmic radiation in former times, comparison of tritium and Cl^{36} activity in meteorites could reflect variations in intensity. The age of meteorites can also be calculated from the A^{36}/Cl^{36} ratio.—*D. B. V.*

168–202. Peters, B. Radioactive beryllium in the atmosphere and on the earth: Indian Acad. Sci. Proc., sec. A, v. 41, no. 3, p. 67–71, 1955.

It is estimated that about 1,000 nuclei of radioactive Be^{10} (2.7×10^6 yrs half-life) are produced per square meter per second by cosmic ray induced nuclear disintegrations in the atmosphere. The conditions for observing the resulting activity in rain water and in various regions on the earth are favorable and may be useful in measuring sedimentation rates and other geological surface changes during the Tertiary.—*Author's abstract*

168–203. Russell, R. D. Abundances of meteoric lead isotopes: Nature, v. 179, no. 4550, p. 92, 1957.

An attempt is made to "date" meteorites by the method used by Holmes and Cahen to calculate the ages of African galenas. The average 206/204 and 207/204 ratios measured by Patterson for iron meteorites are taken as the ratios in primeval lead, and the ratios in ocean sediment lead are used to define the present-day isochron and to evaluate t_0 (as 4.50×10^9 yr). Ages of 330, 5, and −420 million years are obtained for the Nuevo Laredo, Forest City, and Modoc meteorities. If the three had remained isolated, closed systems until recent time, all ages should be zero. If the meteorites were terrestrial lead minerals, it would be concluded that the Nuevo Laredo lead had been isolated from the greater part of its uranium 330 million years ago and that the Modoc lead was anomalous, having been exposed to much larger proportions of uranium during the recent past than during the rest of its history. Either the meteorites were

formed at different times or the Nuevo Laredo and Modoc meteorites have been chemically altered.—*M. C. R.*

168–204. Münnich, K. O. Messungen des C^{14}-Gehaltes von hardten Grundwasser [Measurements of the C^{14}-content of hard ground water]: Naturw., Jahrg. 44, Heft 2, p. 32–33, 1957.

The carbon-14 content of 8 samples of hard ground water from the vicinity of Heidelberg ranges from about 69 to 87 percent of that of living plants; in a typical example the proportion of biogene carbon in the water is 75 percent instead of an expected 60 percent. The excess is probably caused by isotope exchange between CO_2 gas in the pores of the ground and CO_2 and HCO_3— dissolved in the water. The longer percolating water takes to reach the ground water table, the higher the carbon-14 content. The carbon-14 content may also be increased if dissolved calcium carbonate is precipitated in a relatively short time and is not, as assumed, free of carbon-14. The results of the measurements throw light on the relatively high carbon-14 content of fossil bones. The rate of exchange of CO_2 between water and atmosphere can be determined from a comparison of the anomalous carbon-14 content of water plants living in hard waters with the carbon-14 content of the ground water.—*D. B. V.*

168–205. Emiliani, Cesare. Temperature and age analysis of deep-sea cores: Science, v. 125, no. 3244, p. 383–387, 1957.

Paleotemperatures and ages of deep-sea cores have been studied by isotopic analysis, micropaleontological analysis, and carbon-14 dating. Interpretations in terms of glacial chronology by Emiliani and Suess differ from those of the group at the Lamont Geological Observatory. Detailed study of the differences leads to the conclusion that dating of the last temperature rise of the surface waters of the ocean is unsatisfactory at present. Isotopic analysis of closely spaced samples from deep-sea cores, covering the last 20,000 years, and carbon-14 measurements on foraminiferal shells from critical core levels are needed.—*M. C. R.*

MAGNETIC FIELD OF THE EARTH

168–206. Chandrasekhar, S. Effect of internal motions on the decay of a magnetic field in a fluid conductor: Astrophys. Jour., v. 124, no. 1, p. 244–265, 1956.

The decay of a magnetic field in a fluid conductor with internal motions is considered in the case where the magnetic and velocity fields are symmetrical about an axis. The underlying characteristic value problems are solved for certain simple velocity fields, using a method based on a new classification of the basic asymmetric modes of the magnetic field in terms of Gegenbauer polynomials. The principal conclusion is that velocity fields of reasonable patterns and magnitudes can alter the time of decay that will obtain in the absence of motions by quite large factors. Pertaining to the earth, this would mean that the velocities believed to prevail in the core, corresponding to $|\beta| \sim 200$, can prolong the times of decay by factors of the order of 50 or more. For instance, the time of decay of 14,000 years, in the absence of internal motions, could be prolonged to 500,000 years by velocities of reasonable magnitudes and patterns.—*D. B. V.*

168–207. Jensen, Eberhart. Toroidal oscillation of an incompressible conductive fluid sphere in a decay field: Astrophys. Jour., supp. ser., v. 2, no. 16, p. 141–166, 1955.

One of the problems connected with secular variations of the earth's magnetic field is treated mathematically. Given a decay field in a large gravitating body of planetary or interstellar dimensions, the problem is to investigate the periods of oscillations of the decay field during time intervals that are short compared to the decay time. The particular modes of oscillation considered are those resulting from a velocity field which is toroidal in the sense used by Elsasser. The main conclusion drawn from the calculations presented is that both positive and negative eigen-values of ω^2 are present. If there is a rigid boundary surface, the eigen-values apparently form a continuous spectrum; applied to the earth, this result indicates that if the mantle acts as a rigid boundary periodic variations of any period may be present. If there is a free surface of the core (corresponding to the discontinuity of electrical conductivity lying inside the fluid core), and, if Elsasser's data on physical properties of the core are used, the eigen-values of ω'^2 in second, third, and fourth approximations (4.79, 6.07, and 1.23, respectively) yield periods of 96, 85, and 189 years, respectively, within the range of periods recently found in the spectrum of the secular variations of the earth's field.—*D. B. V.*

168–208. Hide, Raymond. The hydrodynamics of the earth's core: p. 94–137 *in* Ahrens, L. H., Rankama, Kalervo, and Runcorn, S. K., Physics and chemistry of the earth, v. 1, New York, McGraw-Hill Book Co., 1956.

A review of hydrodynamic motions in the core with particular reference to the origin of the geomagnetic field.—*M. C. R.*

168–209. Chakrabarty, S. K. The spherical harmonic analysis of the earth's main magnetic field: Indian Jour. Meteorology and Geophysics, v. 5, special no., p. 63–68, 1954.

The main geomagnetic field for epoch 1945 is subjected to spherical harmonic analysis without attaching any arbitrary weights to the different observed data. The method has the effect of smoothing out irregularities in the charted field arising through observational errors or purely local causes. Comparison of the results with those of Vestine and of Jones and Melotte shows that the introduction of arbitrary weights is unnecessary in the derivation of the Gauss coefficients. The existence of a nonpotential field and also of a feeble external potential field is indicated, of orders of magnitude which are sufficient to fit into Schrödinger's calculations based on the unified field theory.—*D. B. V.*

168–210. Egyed, L[ászló]. The magnetic field and the internal structure of the earth: Acta Geol. Acad. Sci. Hungaricae, tomus 4, fasc. 2, p. 221–228, 1956.

Below the Repetti discontinuity, the earth is composed of three different phases of the same substances; the inner and outer cores consist of ultra-high-pressure modifications of the substance of the mantle. The constant part of the earth's magnetic momentum can be attributed to the magnetic momentum of oriented nuclei in the inner core. The nondipole part of the magnetic field and secular variations can be attributed to the outer core. The phase transition and volume increase of the inner core results in a decrease in its angular velocity; the angular velocity of the outer part of the outer core will be approx-

imately that of the mantle, and that of the inner part near that of the inner core. The resulting current cycles explain the formation of isoporic foci, the nondipole part of the magnetic field, and the westerly drift.—*M. C. R.*

168–211. Espersen, J., Andreasen, P., Egedal, J., and Olsen, J[ohannes]. Measurements at sea of the vertical gradient of the main geomagnetic field during the Galathea expedition: Jour. Geophys. Research, v. 61, no. 4, p. 593–624, 1956.

During the Galathea expedition of 1950 to 1952, measurements were made of the vertical gradient of the geomagnetic field to test Blackett's theory of the origin of the earth's magnetism. Three relative, self-recording magnetometers—a needle instrument measuring the vertical component, and needle and rotating-coil instruments measuring the horizontal component—were designed to be lowered to great depths in the sea in nonmagnetic containers. The observations in the Pacific did not provide a conclusive answer because of local disturbances in the geomagnetic field that made the gradient results unreliable, and the breakdown of equipment prevented measurements in more magnetically uniform areas. However, the results do not confirm the fundamental theory.—*M. C. R.*

168–212. Malurkar, S. L. The geomagnetic importance of Andamans in Bay of Bengal: Indian Jour. Meteorology and Geophysics, v. 5, special no., p. 109–112, 1954.

The region between the Andaman Sea and the Gulf of Siam, on the geomagnetic equator, is a maximal one for the *H* component and a saddle one for *F*. Geophysical observations depending on the earth's magnetic field would therefore be shown prominently in this neighborhood.—*D. B. V.*

168–213. Indian Journal of Meteorology and Geophysics. Early history of geomagnetic observations in India at Colaba Observatory, Bombay (1841–1906): Indian Jour. Meteorology and Geophysics, v. 5, special no., p. 19–22, 1954.

The history and instrumental equipment of the Colaba Magnetic Observatory at Bombay are described briefly. The observatory was begun in 1840; records of regular observations, starting with 1841, were systematized in 1846. Together with those of Alibag, these records afford a continuous series covering more than 100 yrs.—*D. B. V.*

168–214. Indian Journal of Meteorology and Geophysics. The Alibag Magnetic Observatory (1904–1954): Indian Jour. Meteorology and Geophysics, v. 5, special no., p. 3–18, 1954.

The Alibag Magnetic Observatory near Bombay was established in 1904, succeeding the Colaba observatory with an overlap of 2 yrs. Its history, physical plant, instrumental equipment, system of observations, reduction and supply of data, special work, and protection from stray electric currents are outlined.—*D. B. V.*

168–215. Custódio de Morais, J. Observations of terrestrial magnetism made on the west coast of India by D. João de Castro in 1538–1539: Indian Jour. Meteorology and Geophysics, v. 5, special no., p. 105–108, 1954.

Surprisingly accurate observations of magnetic declination were made along the west coast of India in 1538–1539 by the Portuguese navigator Dom João de Castro using a shadow instrument with several interchangeable magnetic needles. He also noted that proximity to certain types of rock other than lodestone had a pronounced effect on the needle.—*D. B. V.*

168–216. Mendonça Dias, A. A. de. A hypothetical model of the geomagnetic secular variation in Western Europe and the North Atlantic: Indian Jour. Meterology and Geophysics, v. 5, special no., p. 89–94, 1954.

A hypothetical model of the geomagnetic secular variation in Western Europe and the North Atlantic is suggested, based on analysis of historic values of declination for various stations and of inclination for London. The secular variation for the area in question is explained by movement of the main field as a whole, which is concentric to the globe, and an attempt is made to apply the model to the whole globe. If such movement is valid, the globe at each moment is divided into two separate zones, one with decreasing, the other with increasing, values of I. At present $-\Delta I$ covers the American equatorial region and $+\Delta I$, the Asian-Australian region. Independent regional phenomena for the foci of rapid variation must be considered simultaneously with planetary variation. The antipodal distribution of foci of the same sign excludes the possibility of planetary cause of their variations. Secular variations may be related to hypothetical circulatory movements in the earth's fluid core, in which case the actual foci might be due to subsidiary eddies giving rise to separate fields, each with independent variations.—*D. B. V.*

168–217. Kitamura, Masatoshi. What types of magnetic storm are accompanied by the decreases of the intensity of cosmic rays?: Indian Jour. Meteorology and Geophysics, v. 5, special no., p. 153–156, 1954.

Analysis of cosmic ray data at Huancayo, Peru, for 1936 through 1945 and of the magnetograms at Kakioka, Japan, for the same period reveals a simple relationship between magnetic storms and cosmic ray intensity: a large magnetic storm preceded by a sudden commencement of *SC* type in which the diurnal sum of geomagnetic planetary indices (K_p) is larger than 34, is accompanied by a decrease in cosmic ray intensity of more than 0.7 percent from the previous day. No present theory of magnetic storms seems adequate to explain this relationship.—*D. B. V.*

168–218. Chapman, Sydney. Notes on the theory of magnetic storms: Indian Jour. Meteorology and Geophysics, v. 5, special no., p. 33–40, 1954.

This is a nonmathematical account of the model problems and their solutions used by Chapman and Ferraro to illustrate some aspects of their theory of magnetic storms. A qualitative solution is developed of the motion of an infinite neutral ionized plane sheet of gas (or a succession of such sheets) toward an undirectional magnetic field whose intensity decreases as an inverse power of the distance from an axis to which the sheet is parallel. The gas in the center approaches to a minimum distance from the axis and then recedes. The gas far to either side moves on with little distortion. Between the central and outer parts are two strips whose ions and electrons separate from each other under the influence of the magnetic field. Some charges are deviated to infinity and others are captured by the field and build up a westward electric current to which is ascribed the main phase of a magnetic storm.—*D. B. V.*

168–219. Sipahioglu, Osman. Sur l'intervalle de temps entre les éruptions chromosphériques et les perturbations géomagnétiques [On the time interval between chromospheric eruptions and geomagnetic disturbances] : Acad. Sci. Paris Comptes Rendus, tome 243, no. 19, p. 1427–1430, 1956.

Analysis of all sudden commencements and sudden impulses recorded at the Chambon-la-Forêt and Istanbul-Kandilli observatories in the first 5 days after the beginning of a solar flare effect shows that the time interval between solar eruptions and magnetic storms is very variable but that sudden impulses usually occur between 25 to 30 hours after an eruption.—*D. B. V.*

168–220. Troitskaya, V. A. Korotkoperiodicheskiye vozmushcheniya elektromagnitnogo polya zemli [Short period pulsations of the electromagnetic field of the earth] : Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 32 (159), p. 26–61, 1956.

A detailed analysis was made of short-period variations (ranging from 5 to 180 sec) of the electromagnetic field to investigate the possible correlation between these pulsations and seismic phenomena. Two types of short-period pulsations were discovered : steady pulsations that were repeated at about the same time (universal time) simultaneously at many stations ; and trains of waves also observed again at the same time at stations some distance apart. No relation was found between the recorded magnetic pulsations and local seismic phenomena. The pulsations are attributed to the effect of an electrically charged corpuscular stream emitted by the sun on the geomagnetic field.—*S. T. V.*

168–221. Rikitake, Tsuneji ; Yokoyama, Izumi ; and Sato, Setsuko. Anomaly of the geomagnetic *Sq* variation in Japan and its relation to the subterranean structure : Tokyo Univ. Earthquake Research Inst. Bull., v. 34, pt. 3, p. 197–235, 1956.

Observations at Kakioka and Aburatsubo indicate that the maximum decrease of vertical component of *Sq* occurs about an hour earlier in central Japan than at other observatories in the Far East. Analysis of *Sq* for the Second International Polar Year indicates that the electrical conductivity under Japan is smaller than that of the mean state of the earth and that this weak conducting layer is about 700 km deep. No relation was found between the hypothetical circuit suggested by studies of short-period variations (see Geophys. Abs. 166–36 and 166–258) and the weak conducting region, but the circuit would be almost transparent for slow variations, such as *Sq*.—*M. C. R.*

168–222. Naqvi, Ali. M., and Bhargava, B. N. Recurrence tendency of geomagnetic activity during the current sunspot minimum : Indian Jour. Meteorology and Geophysics, v. 5, special no., p. 195–202, 1954.

Analysis of geomagnetic activity during the period June 1950–June 1953 shows two very long sequences of recurrent (27-day period) moderate magnetic storms. One of these, called the *A*-sequence, has had 40 recurrences, the other, the *B*-sequence, 21 recurrences. Both sequences have continued beyond the period examined. Each shows a periodic variation within a 1-yr period, the *A*-sequence having its maximums near September and minimums near March, the *B*-sequence, the opposite. This variation is explained by the inclination of the solar axis of rotation to the ecliptic ; the heliographic latitude of the earth attains its maximum positive and negative values on September 7 and March 5, respectively. The *M*-

regions responsible for these long sequences are located above 7.2° heliographic latitude and separated by about 130° longitude, one in the northern hemisphere, associated with the *A*-sequence, and the other in the southern hemisphere, associated with the *B*-sequence.—*D. B. V.*

168–223. Pramanik, S. K., and Ganguli, M. K. Sunspots and geomagnetic variation: Indian Jour. Meteorology and Geophysics, v. 5, special no., p. 161–178, 1954.

The variation of geomagnetism with sunspot cycle has been studied on the basis of the records from the Greenwich-Abinger, Coimbra, Cheltenham, and Colaba-Alibag observatories. Each series of data has been treated as a synthesis of the different elements of a time series, beginning with trend, taken for the present purpose as: original data=trend+cycle+accidental fluctuations. Mathematical expressions are fitted to the various series of data to represent secular trends. Linear trends fit the major portion of the variations, but a significantly better fit is obtained in all cases by quadratic or cubic curves. There does not seem to be any 11-yr period in horizontal force and declination but there may be periods of 30 to 40 yrs in both; if there is any cycle present it is definitely larger than the sunspot cycle.—*D. B. V.*

168–224. Toperczer, M[ax]. Das geophysikalische Observatorium Wien-Kobenzl [The Wien-Kobenzl geophysical observatory]: Archiv Meteorologie, Geophysik u. Bioklimatologie, Ser. A, Band 9, Heft 3, p. 406–420, 1956.

A description of the physical plant and instrumentation of the new geophysical observatory of the Zentralanstalt für Meteorologie und Geodynamik, on the Kobenzl northwest of Vienna. Three buildings contain, respectively, the magnetic variometers (2 systems, 1 of Töpfer instruments, 1 of Danish, record *D*, *H*, and *Z* variations); absolute magnetic instruments (Askania Reisetheodolite and Schulze earth inductor, HTM and BMZ magnetometers); and seismic apparatus (3 "Stuttgart" type pendulums, 2 horizontal and 1 vertical, for near-earthquake registration, with recording apparatus comparable to that of Galitzin seismographs).—*D. B. V.*

168–225. Wijk, A. M. van. Notes on the determination of the temperature and induction coefficients of magnetometer magnets: Indian Jour. Meteorology and Geophysics, v. 5, special no., p. 95–102, 1954.

A description of some procedures adopted or developed at the Hermanus Magnetic Observatory in South Africa for determining the temperature and induction coefficients of magnetometer magnets. Formulas are given for use with the QHM instruments.—*D. B. V.*

168–226. Schmidt, H[erbert]. Untersuchungen zur Theorie und Praxis geomagnetischer Schwingungsmessungen mit Angabe einer neuen Schwingzeitmessanlage [Investigations of the theory and practice of geomagnetic oscillation measurements with specifications of a new oscillation measuring device]: Potsdam-Niemegk Geomag. Inst. u. Observatorium Abh., no. 19, p. 43–76, 1956.

Untersuchungen zur photoelektrischen Schwingzeitmessung [Investigations of the photoelectric measurement of oscillation time]: Zeitschr. Geophysik, Jahrg. 21, Heft 1, p. 53–56, 1955.

In the Gauss-Lamont method of absolute determination of geomagnetic horizontal intensity, the accuracy of oscillation time measurement is low relative to that of deflection measurement. Schmidt first calculates the motion of a horizontal magnet suspended by a filament, oscillating with four degrees of freedom. Then, after critical consideration of earlier devices for measuring oscillation time, he describes his new improved apparatus. The essential feature is that, instead of being reflected directly from the oscillating mirror to the photocell, the light first strikes a cylindrical mirror which greatly sharpens the beam and thus shortens the impulse. The rest of the device provides for automatic measurement of the impulse after it is transformed into electrical energy by the photocell. Single impulses of about 2.5×10^{-4} sec duration can be determined accurately.—*D. B. V.*

168–227. Burmeister, F. Erdmagnetische Messungen am Bodensee [Geomagnetic measurements near the Bodensee (Lake of Constance)]: Deutsche Geod. Komm. Veröffentl. Reihe B, Heft 8, pt. 8, p. 1–9, 1955.

H, *D*, and *Z* were measured at 33 stations around the Lake of Constance. The results of the survey are presented as a table and as maps of inclination, declination, horizontal intensity, and vertical intensity for epoch 1955.0.—*S. T. V.*

MAGNETIC PROPERTIES

168–228. Kalashnikov, A. G. Ob izmerenii magnitnykh kharakteristik gornykh porod (metod universal'nogo krutil'nogo magnetometra) [On the measurement of the magnetic properties of rocks (the method of the universal torsion magnetometer)]: Akad. Nauk SSSR Doklady, tom 110, no. 5, p. 776–779, 1956.

A magnetometer for the determination of magnetic susceptibility, remanent magnetization, and the coercive force of rocks consists of two pairs of induction coils. One pair acts as Helmholtz coils, and the other pair, placed inside the first, is used to generate the measured magnetic field; the sample to be measured is placed in the middle of the coils, slightly off exact center. Equations are derived for the three basic magnetic properties in relation to the characteristics of the instrument and the currents feeding the coils. The instrument can also be used to determine the stability of remanent magnetization.—*S. T. V.*

168–229. Pionktovskiy, S. S. Pribor dlya opredeleniya ostatochnogo namagnicheniya gornykh porod [Instrument for determining the remanent magnetism of rocks]: Akad. Nauk SSSR Izv. Ser. geofiz. no. 8, p. 991–996, 1956.

The residual magnetism of different rocks was measured with an apparatus consisting of a d-c motor with long shaft on which a disk was attached on one end and the specimen in the form of a small cube on the other. Opposite the specimen two coils were fixed so that the residual magnetism of the specimen induced on rotation an electromotive force in the coils. This force was amplified, observed on an oscillograph, and measured on a voltmeter. By comparing the induced electromotive force with that produced by a cube of the same size and of known magnetic properties, the apparatus can be calibrated and the residual magnetism of the specimen measured. Measurements are repeated with the specimen in different positions, and the square root of the sum of the

squares of the individual components gives the vector of the residual magnetism of the specimen. A wiring diagram and several characteristic curves are included.—*S. T. V.*

168–230. Saitō, Tomosaburō. On the magnetic properties of natural pyrrhotite: Geol. Survey Japan Bull., v. 7, no. 3, p. 39–46, 1956.

Determination of the magnetic properties of pyrrhotite samples from several mines in Japan showed that the intensity of the natural remanent magnetism was comparable to or stronger than that of the induced magnetism; the intensity of thermoremanent magnetism was nearly comparable to that of magnetite; the Curie point was at 310°–320° C; two types of thermomagnetic curves were found: the Weiss type and one with a single sharp break at 220°–230° C.—*V. S. N.*

168–231. Takenaka, Syunzo. On the relation between the magnetism of pyrrhotite and ore deposits (1st rept) [in Japanese with English summary]: Mining Inst. Japan Jour., v. 71, no. 808, p. 629–632, 1955.

Magnetic susceptibilities of pyrrhotite from ore deposits in five different mines in Japan were measured by the a-c bridge method. Susceptibilities ranged from $18{,}000\times10^{-6}$ to $280{,}000\times10^{-6}$, and were greater than those obtained by the magnetometer method with powdered samples. From these results it is concluded that the strength of magnetization is related to the associated minerals, and therefore the magnetism of pyrrhotite is indicative of the type of deposit and its occurrence.—*B. T. E.*

168–232. Nagata, T[akesi], and Akimoto, S[yun-iti]. Magnetic properties of ferromagnetic ilmenites: Geofisica Pura e Appl., v. 34, p. 37–50, 1956.

Magnetic and crystallographic properties of solid solution of hematite and ilmenite ($x\mathrm{FeTiO_3}\cdot(1-x)\mathrm{Fe_2O_3}$) have been studied in detail for the whole range of $0\leqq x\leqq1$. Both natural minerals from the Haruna pumice, tuff at Minakami, and iron sands of the Gokurakuzi coast and synthetic minerals were examined. The series at atmospheric temperature can be divided into three groups: weakly ferromagnetic where $0\leqq x<0.55$; ferromagnetic, where $0.55<x<0.75$; and paramagnetic, where $0.75<x\leqq1$. The latter group becomes ferromagnetic below a certain low temperature. The Curie point decreases from 670° C. (hematite) in proportion to x, the mol percent of $\mathrm{FeTiO_3}$, and becomes lower than atmospheric temperature for x between 0.75 and 1. The ferromagnetism can be explained if an ordered state is assumed in which Ti^{4+} and Fe^{2+} take positions selectively in the *A* and *B* sublattices, respectively. For $x<0.5$, such ordering seems unlikely.—*M. C. R.*

168–233. Akimoto, S[yun-iti], Nagata, T[akesi], and Katsura, T. The $\mathrm{TiFe_2O_5}$–$\mathrm{Ti_2FeO_5}$ solid solution series: Nature, v. 179, no. 4549, p. 37–38, 1957.

The $\mathrm{TiO_2}\cdot\mathrm{Fe_2O_3}$–$2\mathrm{TiO_2}\cdot\mathrm{FeO}$ solid solution series has been synthetized by sealing a fine powder mixture of pure $\mathrm{Fe_2O_3}\cdot\mathrm{TiO_2}$, and Fe in stoichiometric ratio in a quartz tube evacuated to 10^{-3} mm mercury, and then heating and quenching it. X-ray diffraction data indicate the minerals formed are orthorhombic. Five of six specimens were paramagnetic at atmospheric temperature. The sixth was weakly ferromagnetic, possibly owing to contamination by a small amount of ferromagnetic ilmenite or titanomagnetite. This new phase should be con-

sidered in studying natural ferromagnetic minerals, especially in interpreting oxidation products of the ilmenite-hematite series or titanomagnetite.—*M. C. R.*

168–234. Komarov, A. G. K voprosu o vozraste gabbro-peridotitovoy formatsii na Urale [On the question of the age of the gabbro-peridotite formation in the Urals]: Akad. Nauk SSSR Izv. Ser. geol., no. 9, p. 44–50, 1956.

The magnetic properties of pebbles of igneous rocks in Eifelian conglomerates were investigated in order to correlate them with the platinum-bearing gabbro-peridotite formation of the northern and central Urals and thus confirm the pre-Eifelian age of the latter. The magnetic susceptibility and remanent magnetization and the ratio of remanent to induced magnetization (J_r/J_i) were found to correspond; the gabbro-peridotite is therefore associated with the Caledonian orogeny.

To test the validity of this method of correlation, the same properties were measured for several igneous rocks of similar petrographic character but different ages and of similar age but of different composition and from different regions. These studies indicate that the magnetic properties of igneous rocks (intensity of remanent magnetization, and, particularly, the ratio J_r/J_i) depend on age rather than composition or location, and can be used to determine relative ages and to correlate the rocks even over long distances. The relationship between age and remanent magnetization is not always functional, but more often stochastic; nevertheless it obtains and should be reliable if a sufficiently large number of measurements are made and analyzed statistically.—*D. B. V.*

168–235. Graham, John W. Paleomagnetism and magnetostriction: Jour. Geophys. Research, v. 61, no. 4, p. 735–739, 1956.

The role of magnetostriction in the problem of rock magnetism has heretofore been neglected. Based on some experimental observations and on reconsiderations of well known factors affecting rocks, the conclusion is reached that magnetostriction may figure prominently in establishing the directions of magnetization observed in many cases. Therefore, the practice of interpreting meager magnetic data in terms of polar wandering and continental drift can be in error.—*Author's abstract*

168–236. Deutsch, E. R. The measurement of magnetic hysteresis in rocks and minerals at high temperatures: Jour. Geomagnetism and Geoelectricity, v. 8, no. 3, p. 108–117, 1956.

An experimental method is described, designed chiefly to furnish data for a study of the direction, and stability with time, of thermoremanence in rocks. Specimens were heated to the Curie point in an evacuated electric furnace. Two pick-up coils were arranged close to the gap of a tuned a-c electromagnet providing a maximum field H of 2,400 oersteds. These were balanced to make their resultant e. m. f. zero in the presence of H alone, and proportional to dI/dt when a specimen of intensity of magnetization I was in the gap. This e. m. f. was applied to the vertical plates of a cathode ray oscilloscope. The potential drop over a small resistance in the electromagnet input was applied to the deflection coils, giving a measure of H. Computations based on the resulting pattern on the cathode-ray-oscilloscope screen yield a loop of the I-H type, with I in arbitrary units, from which the coercivity can be evaluated. A pronounced "sawtooth" pattern has been observed in the (dI/dt)-H traces

of pyrrhotite and franklinite specimens, particularly just below the respective Curie points.—*Author's abstract*

168–237. Jaeger, J. C. Palaeomagnetism: Australian Jour. Sci., v. 19, no. 3, p. 100–103, 1956.

A review of recent studies of rock magnetization and their application to problems of polar wandering, continental drift, reversals of the earth's field, and possible applications in stratigraphic correlation and petrology.—*D. B. V.*

168–238. Bradley, John. The meaning of paleogeographic pole: New Zealand Jour. Sci. Technology, sec. B, v. 38, no. 4, p. 354–365, 1957.

Examination of the paleomagnetic evidence for "polar wandering" leads to the conclusion that Runcorn's map (see Geophys. Abs. 165–273) is wholly compatible with and perhaps interpretable only in terms of continental drift. The various types of poles are defined; a "rotational pole" is at the intersection of the axis of mean rotation and the geoid; a "geographic pole" is the point of intersection of the earth's surface and the rotational axis at a given time; a "center of wandering" is the point of emergence at the surface of a theoretical axis about which the crust as a whole may be considered to rotate independently; a "paleogeographic pole" is a time-place concept whose meaning for any individual depends on his preferred hypothesis of crustal movement. In paleoclimatic and geomagnetic senses and in the drift sense accepted in this paper, a paleogeographic pole is a point on the globe which may be regarded as having been the geographic pole at a former time. The term "wandering poles" has little meaning outside rigid-earth or rigid-crust hypotheses; the practice of discussing crustal movements in terms of polar wandering is confusing and should be avoided. Runcorn's plots of Precambrian poles are only an indication that the crust has rotated, but it may be concluded more definitely that the British Isles and North America have moved northwards since the Cambrian and have drifted apart since the Permian.—*D. B. V.*

168–239. Die Umschau. Wanderung des erdmagnetischen Nordpols [Wandering of the north magnetic pole]: Umschau, Jahrg. 56, Heft 16, p. 502, 1956.

The results of independent paleomagnetic research in North America and Europe show that the position of both continents has not changed significantly at least since Precambrian time, thus contradicting the continental drift theory. Six hundred million years ago the north magnetic pole lay slightly north of the present Equator in the middle of the Pacific Ocean; since then it has described an arc across the earth's circumference, moving irregularly and rapidly, with numerous fluctuations of considerable extent in the course of a few thousand years. Paleoclimatic findings show that there has been no corresponding significant displacement of the geographic pole at least since Carboniferous period at which time the magnetic pole was somewhere in southern Korea.—*D. B. V.*

168–240. Steinert, Harald. Fossile Magnete als Erdgeschichtszeugen [Fossil magnets as tools of earth history]: Umschau, Jahrg. 57, Heft 4, p. 101–103, 1957.

A review of paleomagnetism, its causes, and the results of current research. The position of the geographic pole is somewhat consistent with the direction of

the magnetic axis. Paleomagnetism shows that the north pole in the past has wandered as much as 90° over the earth. Tensions in the crust resulting from such wandering might help explain some of the earth's major structures.—*D. B. V.*

168–241. Deutsch, E. R. The magnetic hysteresis of rocks and minerals at high temperatures: Jour. Geomagnetism and Geoelectricity, v. 8, no. 3, p. 118–128, 1956.

The coercivity, remanence and saturation magnetization of a number of minerals and rocks have been obtained as a function of temperature, using alternating fields up to 2,300 oersteds. These results suggest that most of the specimens examined can retain thermoremanence for long periods, even at high temperatures. Irregularities occurring in some of the temperature curves indicated the presence of more than one ferromagnetic constituent. Heat treatment in several cases caused considerable changes in the hysteresis curves measured at atmospheric temperatures. The thermomagnetic behaviour of two basalts has supported the view that the reversed magnetization of certain rock formations is due, not to abnormal magnetic properties on the part of the material concerned, but to a past reversal of the geomagnetic field.—*Author's abstract*

168–242. Watson, G. S. Analysis of dispersion on a sphere: Royal Astron. Soc. Monthly Notices, Geophys. supp., v. 7, no. 4, p. 153–159, 1956.

The direction of remanent magnetism of specimens from a given site may be represented by points on a unit sphere grouped closely or loosely about a pole. R. A. Fisher has suggested that the appropriate probability density on the sphere is given by exp ($k \cos \theta'$), where k is a precision parameter and θ' is the angle between the polar and observation vectors. When $k=0$, the density is uniform and the points are randomly distributed; when k is large, the density is confined to the region about the pole. In this paper a series of approximate tests of significance is derived for hypotheses about k and the polar vector by using the analysis of variance approach; the tests are in a form familiar to statisticians and are sufficiently accurate for most practical situations. As an example, the tests are applied to data on samples from the Torridonian sandstone series.—*M. C. R.*

168–243. Watson, G. S. A test for randomness of direction: Royal Astron. Soc. Monthly Notices, Geophys. supp., v. 7, no. 4, p. 160–161, 1956.

The significance test for $k=0$ (see preceding abstract) in statistical studies of remanent magnetization is a test of randomness of unit vectors. A short table is given of the 5-percent and 1-percent significance points to facilitate practical application of the test.—*M. C. R.*

168–244. Gough, D. I. A study of the palaeomagnetism of the Pilansberg dykes: Royal Astron, Soc. Monthly Notices, Geophys. supp., v. 7, no. 4, p. 196–213, 1956.

The remanent magnetization of oriented speciments of the mafic parts of five Pilansberg dikes from depths of a few thousand feet in the Witwatersrand is consistent over considerable distances. The mean directions from the five dikes indicate a north-seeking magnetic pole with inclination +69.3° and azimuth N 24.0° E. (The mean inclination ranges from 60.6° to 73.1° and

mean azimuth from 7.9° to 45.5° in the five dikes.) If the dikes acquired their thermoremanent magnetization in a geocentric dipole field, the north magnetic pole at the date of intrusion was in eastern Abyssinia at lat 7½° N, long 42½° E. The age of the dikes is uncertain, but it is probably 300 to 400 million years, or Paleozoic.—*M. C. R.*

MAGNETIC SURVEYS

168–245. Haalck, F. A torsion-magnetometer for measuring the vertical component of the earth's magnetic field: Geophys. Prosp., v. 4, no. 4, p. 424–441, 1956.

The paper describes a vertical component magnetometer for field work whose magnet system is provided with a torsion axis and in which torsion serves as a standard of measurement. When a measurement is taken the magnetic axis of the system is brought back into the horizontal position by altering the angle of twist (null-method). The angle of twist is thus a direct measure of the vertical intensity. The instrument is within wide limits independent of the magnetic north-south direction and may therefore be set up in practically any position. The magnet system is temperature compensated, well damped and provided with an automatic clamping device. With a scale value of 25 gammas per scale division the range of the instrument for direct measurements is 65,000 gammas. A tripod of special design enables a measurement to be taken in about one minute. The weight of the torsion magnetometer inclusive of tripod is only 2.9 kg (6.4 lb).—*Author's abstract*

168–246. Akopyan, Ts. G. Vliyaniye rel'yefa mestnosti na pole Z_a v svyazi s kharakterom namagnicheniya effusivnykh porod [The influence of local topography on the Z_a field in connection with the kind of magnetization of the effusive rocks]: Akad. Nauk Armyanskoy SSR Doklady, tom 21, no. 3, p. 103–106, 1955.

Interpretation of magnetic measurements is often difficult where great variations of topography are combined with complex structure. In the Caucasus, for example, a layer of volcanic sediments or slates is overlain by either andesite basalt or dolerite basalt. Over the effusive rocks, anomalies of opposite signs were observed at top and bottom. A negative anomaly is observed over the top of dolerite basalt; a positive anomaly, over the bottom. Positive anomalies are observed over the tops of andesite basalt, or volcanic tufts or similar effusive rocks; and negative anomalies, at the bottom. The shape of the Z_a-curve over the dolerite basalt is the mirror image of the topographic profile, but over the andesite or tuffaceous formations it is the direct image of the profile.—*S. T. V.*

168–247. Tarbox, George E. Recent developments in airborne minerals exploration: Mines Mag., v. 47, no. 1, p. 29–32, 1957.

A discussion of recent developments in airborne geophysics, emphasizing the nuclear magnetic resonance magnetometer and newer electromagnetic techniques.—*L. C. P.*

168–248. Hunter, K. E., and Whitaker, J. C. Nuclear magnetometer reveals structural grain with aerial mapping: Oil and Gas Jour., v. 54, no. 66, p. 144–145, 1956.

A nuclear precession magnetometer is being used in airborne magnetic surveys. The advantages are that the magnetometer gives an absolute value of

the earth's magnetic field and the reading is independent of the orientation of the detecting device with respect to the earth's field. The light weight of the magnetometer permits its use in light aircraft.—*D. R. M.*

168–249. Zmuda, Alfred J., and McClay, John F. A method of interpolating magnetic data under conditions of mutual consistency: Jour. Geophys. Research, v. 61, no. 4, p. 667–672, 1956.

Because of the discreteness of the data obtained in magnetic surveys, it is necessary to interpolate between measured points before charts can be drawn. Rigorous relations connecting surface variations of different elements are herein introduced into the interpolation formulas, so that the resulting charts are mutually consistent. Related elements are continued by a power series in which the unknown coefficients are computed under the conditions for consistency.—*Authors' abstract*

168–250. Pudovkin, I. M. O variatsiyakh magnitnogo polya pri proizvodstve tochnykh regional'nykh ayeromagnitnykh s'yemok [Variations of the magnetic field during precise regional aeromagnetic surveys]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 8, p. 997–998, 1956.

A continuation of the article (see Geophys. Abs. 167–185) on geomagnetic disturbances in high latitudes that interfere with aerial navigation and airborne magnetic surveys. Variations of the magnetic vectors H, Z, and D were measured and recorded with magnetometers of the Brunelli type; variations of the total magnetic vector T can then be determined from the formula $\delta T = -\delta Z \sin I + \delta H \cos I$. Where I (magnetic inclination) approaches $\pi/2$, it can be assumed that $\delta T = \delta Z$. From the observed data a formula is derived for δT that is applicable to the points 300 km apart. The values of δT given by this formula are to be taken as corrections of the measured values in precise aeromagnetic surveys.—*S. T. V.*

168–251. Lehmann, Martin. Geomagnetische und geoelektrische Untersuchungen an Lamprophyrgängen in der Lausitz [Geomagnetic and geoelectric investigations on lamprophyre dikes in the Lausitz massif]: Geologie, Jahrg. 5, Heft 6, p. 515–527, 1956.

Because of their high ferromagnesian mineral content, the lamprophyre dike swarms intruding the Lausitz granite massif in Germany produce magnetic anomalies of several hundred gammas (in some places, as much as 4,000 gammas) and are easily delineated by magnetic surveys. The magnetic method is therefore recommended as an adjunct to future geologic mapping. The electrical surveys were found useful in indicating depth of weathering. Results of the geophysical measurements are presented in numerous graphs and sketch maps, including a large map of the vertical magnetic anomalies in the Oberrottendorf vicinity.—*D. B. V.*

168–252. Murozumi, Masayoshi, and Saitō, Tomosaburō. Geological prospecting at Kitatoyotsu District, Hokkaidō [in Japanese with English summary]: Geol. Survey Japan Bull., v. 7, no. 4, p. 35–40, 1956.

Magnetic and electromagnetic surveys were made to determine the extent of the iron placer on the Kitatoyotsu terrace at Oshamambe, Yamakoshi-gun, Hokkaidō.—*V. S. N.*

168–253. Warren, Jack R. A study of magnetic anomalies associated with ultrabasic dikes in the Western Kentucky Fluorspar District: Kentucky Geol. Survey Bull., no. 19, 38 p. and 4 plates, 1956.

Magnetic traverses were made at right angles to the strike of the dikes at station spacings of 100 to 200 feet where the exact position of the dikes was unknown, and spacings of 6 to 25 feet for more exact location. Susceptibilities of cubes of the dike rocks and of separates of the magnetic minerals were measured to aid in the interpretation. In the 6 dikes measured, susceptibilities of cube samples ranged from 0.045×10^{-3} to 5.9×10^{-3}, and 95 percent of the magnetization is induced. In contrast, the Elliott County dike has a susceptibility of 9.0×10^{-3} and the magnetization is 95 percent remanent. Approximately half of the known 20 dikes in the district are too narrow, too deep, or do not possess magnetic susceptibility great enough for detection; in others where large anomalies were obtained the magnetic method can be useful in tracing the dikes.—*M. C. R.*

168–254. Grujić, Nikola, and Ristić, Volislav. Detalj iz geofizičkih ispitivanja na Juriji (Planina Golija) [A detail of the geophysical exploration at Jurija, Golija Mountains]: Srbija Zavod geol. i geofiz. istraživanja Vesnik, tome 11, p. 397–404, 1954.

A description of the self-potential, potential-drop-ratio and magnetic surveys on the Golija Mountain in Yugoslavia in search for sulfide ores known to crop out on the mountain.—*S. T. V.*

MICROSEISMS

168–255. Lacaze, Jean [R]. Sur les miscroséismes produits par certains fronts froids à Alger [On the microseisms produced by certain cold fronts at Algiers]: Acad. Sci. Paris Comptes Rendus, tome 243, no. 17, p. 1229–1230, 1956.

Study of the records at Algiers between October 1954 and May 1955 shows that a cold front in the Sicilian Channel (between Sicily and Tunisia) produces miscroseisms whose periods coincide on the vertical and E–W seismographs. It is not certain, however, that these are Rayleigh waves and from any other direction they would be impossible. Love waves resulting from local modification of Rayleigh waves originating in the Sicilian Channel or certain other regions would have periods very close to those observed.—*D. B. V.*

RADIOACTIVITY

168–256. Diamond, H[erbert], Friedman, A. M., Gindler, J. E., and Fields, P. R. Possible existence of Cm^{247} or its daughters in nature: Phys. Rev., v. 105, no. 2, p. 679–680, 1957.

The absence of any detectable Pu^{243} daughter activity in a sample of curium containing two micrograms of Cm^{247} indicates that the alpha half-life of Cm^{247} exceeds 4×10^{7} yrs and probably exceeds 9×10^{7} yrs. If the limit of detection of curium in nature is set at one atom of Cm^{247} per 10^{15} atoms of rare earth, Cm^{247} can be found if it has not decayed more than 40 half-lives (that is, if the age of terrestrial material is 5 billion yrs, the half-life must be 1.3×10^{8} yrs, and if the age is 9 billion yrs the half-life must be 2.2×10^{8} yrs). Cm^{247} and its daughters must have been an important source of radioactive heat for at least the first half billion yrs after the formation of the elements.—*M. C. R.*

168–257. Picciotto, E. [E.], and Wilgain, S. Confirmation de la période du Thorium–232 [Confirmation of the half life of thorium–232] : Nuovo Cimento, ser. 10, v. 4, no. 6, p. 1525–1528, 1956.

To test Wasserburg and Hayden's suggestion that the systematic discrepancy between lead-thorium and lead-uranium ages is due to a 10–15 percent error in the half life of thorium–232 (see Geophys. Abs. 161–132), the period was measured again in a new way. From the activity of radiothorium (Th^{228}) in equilibrium, measured by the five-branch α-stars produced by this nuclide on nuclear emulsion plates, the decay constant of Th^{232} was calculated as $\lambda=(1.58\pm0.03)\times10^{-18}s^{-1}$, corresponding to a half life of $(1.39\pm0.03)\times10^{10}$ years. This is in perfect agreement with the value obtained by Kovarik and Adams in 1938 but not with that of Senftle, Farley, and Lazar (see Geophys. Abs. 168–258).—*D. B. V.*

168–258. Senftle, F. E., Farley, R. A., and Lazar, N. Half-life of Th^{232} and the branching ratio of Bi^{212} : Phys. Rev., v. 104, no. 6, p. 1629–1632, 1956.

The half-life of Th^{232} has been calculated by determining an absolute gamma-disintegration rate for Tl^{208} in equilibrium with Th^{232} for three old thorium nitrate salts and one natural thorite sample. The branching ratio, $\alpha/(\alpha+\beta)$, for Bi^{212}, a necessary parameter in the calculation, was also measured. The half-life of Th^{232} was found to be 1.4×10^{10} years within an estimated error of 5 percent, which is essentially in agreement with the presently accepted values. The branching ratio, $\alpha/(\alpha+\beta)$, of Bi^{212} was found to be 0.362 ± 0.006, about 7.4 percent higher than the currently accepted values.—*Authors' abstract*

168–259. Smith, W. L., and Flanagan, F. J. Use of statistical methods to detect radioactivity change due to weathering of a granite : Am. Jour. Sci., v. 254, no. 5, p. 316–324, 1956.

Forty-four samples of the Conway granite were collected from the red and green phases of the rock at the Redstone, New Hampshire quarries. A large variation in radioactivity as measured by β-counting is shown between individual samples.

Inspection of the data shows that the red phase is higher in radioactivity than the green. An analysis of variance with a single variable of classification shows that the means of the fresh and weathered red phases are not significantly different, whereas a "t" test using differences between pairs of the fresh and weathered green samples shows that the means of these two sets differ significantly. From these tests and a comparison of the variances of the respective sets, it is inferred that weathering has had a significant effect on the green phase only.

It has been shown, by comparing the variances of the subsets of data with the known variance of the method of measurement, that some external factor such as variations in mineralogic composition or differential leaching or adsorption may be responsible for the variations in radioactivity.—*Authors' abstract*

168–260. Shavrova, N. N. Zametka o soderzhanii radiya v lavakh vulkanov Klyuchevskoy gruppy [A note concerning the radium content of the lavas of the volcanoes belonging to the Klyuchevskaya group] : Akad. Nauk SSSR Lab. vulkanol., Byull. vulkanol. stantsii, no. 24, p. 65–67, 1956.

Analysis of several specimens of lava from different volcanoes of the Klyuchevskaya group showed no significant differences in the chemical composition

of the lavas of different ages of different volcanoes. The radium content in general ranged from 0.68×10^{-12} to 0.99×10^{-12} g per g. The radium content is about the same as that in lavas from the Hawaiian Islands.—*S. T. V.*

168–261. Shibata. Isamu. Measurements of radioactivity in the Saga Coalfield, Kyūshū: Mining Geology (Japan), v. 6, no. 22, p. 262–264, 1956.

Some effects of igneous intrusions on the coalfield were determined by measuring the relative amount of radioactivity of the coal-bearing strata. Radioactivity is highest in the Meiji Saga mine where the coal seam is locally intruded by lithoidite and is lowest in the Tateyama mine where there are no igneous intrusions. In the Meiji Saga mine, radioactivity increases perceptibly within 10 m of the lithoidite intrusion.—*V. S. N.*

168–262. Koczy, Fritz F., Tomic, Ernst, and Hecht, Friedrich. Zur Geochemie des Urans im Ostseebecken [On the geochemistry of uranium in the Baltic Sea basin]: Geochim. et Cosmochim. Acta, v. 11, no. 1/2, p. 186–102, 1957.

The uranium content has been determined for samples of water from 15 rivers flowing into, and 9 places in the Baltic Sea and Skagerak, and for 3 bottom sediments, and the radium content for samples from 2 rivers and 5 places in the Baltic. The uranium content of river water from regions of igneous rocks is low, averaging 0.5×10^{-6} grams per liter, higher for sedimentary rock regions (maximum 12.8×10^{-6} g per l), indicating that uranium is more easily leached from sediments. The radium content of river water is not in equilibrium with the uranium content; the uranium must be more soluble.

The uranium content of the Baltic Sea is variable, ranging from 0.77 to 5.6×10^{-6} g per l. Correlation with salinity is marked except in the southeastern part and in deep water. Surface water increases in uranium are explained by high content of inflowing river waters, deep water increases by oxygen deficiency. The latter also accounts for the high content of sea bottom sediment (3.2 to 10.3×10^{-6} g per l); uranium VI is reduced to uranium IV, forming insoluble compounds which settle to the bottom. Detailed study of the distribution of uranium in sediments, supplemented by radiocarbon age determinations, may throw light on past changes in the state of ventilation of the deep basins of the Baltic Sea. The considerable precipitation of uranium on the Baltic Sea shelf indicated by these studies seems to be caused by biologic activity which in turn causes oxygen deficiency.—*D. B. V.*

168–263. Koczy, F[ritz] F., Picciotto, E. [E.], Poulaert, G., and Wilgain, S. Mesure des isotopes du thorium dans l'eau de mer [Measurement of thorium isotopes in sea water]; Geochim. et Cosmochim. Acta v. 11, no. 1/2, p. 103–129, 1957.

The Th^{232}, Th^{230}, Th^{228} and Th^{227} content of 8 samples of sea water from coastal waters in the Skagerak and Gullmarfjord (Sweden) has been determined separately. The average concentrations corresponding to a total volume of 140 liters of water are as follows: T^{228}, $(4.0\pm1.4)\times10^{-21}$; $Th^{227}<7\times10^{-23}$; $Th^{232}<2\times10^{-11}$; and $Th^{230}<6\times10^{-16}$ g per ml. One high value of Th^{230} (26×10^{-16} g per ml) is attributed to nonhomogeneous distribution of Th^{230} in the sea. Less than 2 percent of the Th^{230} resulting from U^{238} disintegration can be accounted for, a lack that must be correlated with the presence of unsupported Th^{230} in the deep-sea sediments and proves the hypothesis of Th^{230} precipitation with the

sediments. Radium is in excess by a factor of 6 with respect to its equilibrium with Th^{230}, possibly because of redissolution of part of the radium originating from the Th^{230} of the sediments. A surprising excess of Th^{228} over its equilibrium value with Th^{232} is attributed to excess of its parent Ra^{228} brought in by rivers or redissolved from the sediments. More than 90 percent of the Th^{227} cannot be accounted for; it probably is precipitated with the sediments along with Th^{230}. In both the U^{238} and Th^{232} families, a radium isotope (Ra^{226} and Ra^{228}, respectively) seems to be in excess of its parent thorium isotope (Th^{230} and Th^{232}). The presence of unsupported Ra^{226} (T=1,600 yrs) and Ra^{228} (T=6.7 yrs) is of great interest; study of their distribution should yield valuable data on their diffusion rates and on deep currents.

In general, the ocean seems to be characterized by extremely low concentration of nuclides of all three radioactive families and by total disruption of radioactive equilibrium in these families.—*D. B. V.*

168–264. Rona, Elizabeth, Gilpatrick, L. O., and Jeffrey, Lela M. Uranium determination in sea water: Am. Geophys. Union Trans., v. 37, no. 6, p. 697–701, 1956.

Samples of sea water from the north Atlantic, north Pacific, Gulf of Mexico, and Straits of Florida were analyzed for uranium by the isotope-dilution method. The average concentration is 3.1 to 3.5 micrograms of uranium per kilogram of sea water. The uranium content of the surface waters is higher in the Gulf of Mexico than in the north Atlantic and north Pacific, but the deep-water contents are similar. These results indicate that the surface and deep waters of the Gulf of Mexico are different water masses. The average uranium content here determined allows a satisfactory explanation of the radium balance in the Pacific cores studied by Kröll without resort to any assumption about the variation in the uranium content of the ocean with time.—*M. C. R.*

168–265. Cook, Melvin A. Where is the earth's radiogenic helium?: Nature, v. 179, no. 4552, p. 213, 1957.

Some 6×10^9 g per yr of helium are generated from the lithosphere and cosmic ray action. It has generally been assumed that He^4 has passed out through the exosphere and that the present rate of loss through the exosphere balances the rate of exudation from the lithosphere. However, computation of the rate of loss of He^4 by Spitzer's formula with an assumed temperature of 1,500° K at the base of the exosphere is only 10^{-7} as great as the replenishment rate from the lithosphere. Computed rates of escape of He^3 do not take into account the replenishment, which is considerably greater than the loss. The He^3/He^4 ratio in the atmosphere is about 10 times that in the lithosphere; to maintain this ratio, a source of about 10^3 g He^3 per yr is necessary if the exosphere temperature is 1,500° K, and a source of 2×10^6 g per yr if the exosphere temperature is 2,500° K. A non-steady-state solution, in which He^4 is still inincreasing, and the high He^3/He^4 ratio in the atmosphere may be the result of terrestrial accretion of meteoritic material with high He^3/He^4 ratios is perhaps the answer; but this assumption leads to anomalous atmospheric chronometry that, however, is in approximate agreement with the chronometry obtained from the ratio of annual uranium flux in river water to the total uranium in the the oceans.—*M. C. R.*

168–266. Běhounek, F., and Majerová, M. Radon content of the air: Nature, v. 178, no. 4548, p. 1457, 1956.

Experimental determination of the radon content of air by direct ionization measurements and by the filter-paper method indicate that even in a closed room there is no constant ratio between the active deposit collected on the filter paper and the radon content of the air.—*M. C. R.*

RADIOACTIVITY LOGGING AND SURVEYING

168–267. Ivanova, V. F., and Khristianov, V. K. Neytronnyy karotazh dlya poiskov promyshlennykh kontsentratsiy bora [Neutron logging in prospecting for commercial deposits of boron]: Akad. Nauk SSSR Geokhimiya, no. 2, p. 68–73, 1956.

Experimental neutron logging in wells drilled in formations containing boron, chlorine, and other elements with large capture cross sections for thermal neutrons, indicates that, as expected from theory, the presence of even 0.2 percent of boron can be detected. Geiger-Müller counters were used in uncased holes in the experiments. The distance between the source of the primary radiation and the indicator should be as great as possible to increase the resolving power so that even thin strata containing boron can be discovered.—*S. T. V.*

168–268. Bespalov, D. F., and Grumbkov, A. P. Novaya radiometricheskaya apparatura [The new radiometric equipment]: Neftyanoye Khozyaystvo, no. 9, p. 39–43, 1956.

A description of scintillation logging devices.—*S. T. V.*

168–269. Swift, Gilbert, and Norelius, R. G. New nuclear radiation logging method: Oil and Gas Jour., v. 54, no. 76, p. 109–113, 1956.

In Venezuela multispaced neutron logs have been used successfully in distinguishing between gas and oil zones. The work in this area indicates that normally there is a fixed relationship between the ratio of the deflections of the two neutron curves. Large deviations of this ratio from the norm in high deflection zones will indicate gas or a dense formation. Theory suggests that a predominant, but not necessarily unique, relationship should exist between the intensities of radiation observed at different distances from a neutron source. Showing departures from this norm, which leads to positive identification of changes in and around the borehole, is the distinct advantage of the multispaced curves.—*D. R. M.*

168–270. Prezewłocki, Kazimierz. Zastosowanie metod radioaktywnych do profilowania odwiertów [The application of radioactive methods in well logging]: Przeglad geol., zeszyt 9, p. 389–404, 1956.

A review of the principles, techniques, and instruments of different methods of radioactivity logging. Examples of the application of different methods, graphs, and the results obtained are discussed. In the concluding section of the paper description is given of various schemes and instruments.—*S. T. V.*

168–271. Flerov, G. N., and Alexeyev, F. A. The use of radioactive radiations in prospecting and developing oil deposits in the USSR: World Petroleum Cong., 4th sess., Rome, Proc.. sec. 1, p. 737–746, 1955.

A review of radiometric methods used in petroleum exploration and exploitation in the U. S. S. R. Gamma-ray and neutron logging have been used commercially since 1948 and 1950, respectively. The latter has proved especially effective in locating the water-oil contact in cased wells. Radioactive isotopes are being used in all oilfields in ever-increasing scope, mostly for controlling the cementing of casings and the dependability of insulation of water-bearing and oil sands. The use of radioactivity surveys in exploration for oil is being investigated. First results show low gamma activity over oilfields and a surrounding belt of greater intensity. The nature of the anomalies has not been determined, but their occurrence has no bearing on the character of the soil or underlying rocks.—*D. B. V.*

Fedynskiy, V. V., and Komarov, S. G. Geophysical investigation of drillholes in USSR.—See Geophys. Abs. 168–106.

168–272. Katayama, Nobuo, and Mazima, Tetchū. Beta counter type DC–P1 for precise measurement in galleries as well as in laboratories [in Japanese with English abstract]: Mining Geology (Japan), v. 6 (3), no. 21, p. 162–168, 1956.

A detailed description of a beta counter, constructed for precise measurements both in the field and in the laboratory. Both probe and counter are waterproof and airtight and the background count of the instrument is low and stable.—*V. S. N.*

168–273. Berbezier, J. Le matériel employé dans les mesures radiométriques de terrain [The equipment used in radiometric surveys]: Rev. Industrie Minérale, Recherche minière, special no. 1 R, p. 158–176, 1956.

Equipment described includes Geiger-Müller and scintillation counters, gammaphones, gammameters, and gammabetameters; the complete truck apparatus for deep borehole exploration; a tunnel lined with Geiger counters permitting miners to make a simple estimate of ore grade to avoid unnecessary transportation; and the dosimeter for determining uranium content in the laboratory.—*B. T. E.*

168–274. Hohne, Fred C. Radiometric assaying of uranium ore in place: Mines Mag., v. 46, no. 9, p. 45–46, 1956.

Geiger or scintillation counter readings in short drill holes at the surface or in mines can be used to determine the grade of uranium ore in place.—*L. C. P.*

168–275. Kellogg, William Crowe. The development and interpretation of aerial radioactivity surveys: Mines Mag., v. 46, no. 7 p. 31–34, 1956.

Airborne radioactivity surveys can be interpreted in terms of near-surface structure and lithology if used in conjunction with surface geologic information. The method is not limited to exploration for uranium; it can be used to solve geologic problems in the search for any mineral.—*L. C. P.*

168–276. Vaňková, Věra. Několik poznámek k použití radiometrické aparatury v terénu [Some remarks on the utility of radiometric equipment in the field]: Československý Časopis pro Fysiku, ročník 6, no. 4, p. 488–491, 1956.

Profiles of total gamma-ray intensity measured with a Geiger counter in shallow pits in the surface soil placed 10 m apart in line across known faults

show a small positive anomaly over one fault, none over others, and a negative anomaly over water-logged ground in the vicinity of a known fault zone. It is concluded that equipment used cannot locate faults where even their approximate position is unknown in advance.

In the appended discussion (p. 491–492), J. Bačkovský and R. Seidl state that the method is less suitable for the search for faults than for their precise localization under favorable conditions.—*H. F.*

SEISMIC EXPLORATION

168–277. Salvatori, Henry. New developments in seismic methods [with discussion]: World Petroleum Cong., 4th sess., Rome, Proc., sec. 1, p. 605–618, 1955.

A review of recent extensions and refinements of seismic methods, such as pattern shooting, automatic volume control, magnetic tape recording, use of air and auger drills, specialized tracked vehicles, and cable handling devices, and new interpretation techniques.—*D. B. V.*

168–278. Goedicke, T. R., and Locke, E. R. New techniques in marine geophysics: World Oil, v. 143, no. 7, p. 122–128, 1956.

A general review of new seismic detectors, cables, recorders and data processing systems developed for use in marine exploration.—*L. C. P.*

168–279. Gaither, V. U. Index of wells shot for velocity (Fifth supplement): Geophysics, v. 22, no. 1, p. 120–135, 1957.

Information is tabulated on 759 velocity surveys, most of which were shot in 1955 and 1956, and corrections or additional information are given for 7 surveys previously tabulated.—*M. C. R.*

168–280. Hall, S. H. Scale model seismic experiments: Geophys. Prosp., v. 4, no. 4, p. 348–364, 1956.

Experiments were made in a tank 1 m square and 30.5 cm deep filled with water in which the model was immersed. A three-electrode spark mounted in air above the water surface was used as the source and barium titanate as a detector. The effect on the pulse shape of transmission through the air-water interface and the change of pulse shape with depth were investigated. In transmission through the air-water interface no great change in pressure amplitude was observed; the only marked difference was the appearance in the water of a small rarefaction and compression following the initial compression. Marked changes in wave form were observed as the depth of the detector below the water surface was increased and when a slab of slate was used in the tank. Many records are reproduced.—*M. C. R.*

168–281. Voyutskiy, V. S. O gruppirovanii seysmopriyemnikov [Multiple geophones]: Prikladnaya geofiz., vypusk 14, p. 23–46, 1956.

A discussion of multiple geophones and the effect of their use on the signal-to-noise ratio. The amplitude of the disturbing vibration is determined by the geometric summation of the component waves, so that the grouping is advantageous if the component waves decrease or even nullify one another because of phase differences. The effect of the multiple geophone is a small

deviation of the incoming wave the measure of which is the coefficient of directional discrimination. The detailed analysis includes numerous graphs and seismograms showing the effect of the number of geophones in each group and different directions of the geophone lines.—*S. T. V.*

168–282. Celmiņš, Aivars. Theoretische Fragen über Bündelung von Geophonen bei Untertage-Messungen [Theoretical questions on multiple geophones in underground measurements] : Geophys. Prosp., v. 4, no. 4, p. 305–393, 1956.

The arrays of multiple geophones used in underground seismic prospecting must satisfy two conditions: in each group only a few geophones can be used; the array must work in a rather wide frequency band. In the present paper the effect of the 3 parameters (geophone spacing, sensitivity, and time shift) of a linear array is investigated in order to improve the directional sensitivity of the array. Necessary conditions which are independent of the frequencies are found for the optimum sensitivities of the geophones in a linear array. The optimum values of the parameters mentioned above are calculated for arrays of 2 and 3 geophones and for a frequency band width which may be used in underground seismic prospecting.—*Author's abstract*

168–283. Groshevoy, G. V., and Pasechnik, I. P. Vysokochuvstvitel'nyy polevoy seysmograf MPS–1 dlya zapisi korotkoperiodnykh komponent seysmicheskikh voln [The MPS–1 seismograph designed as a high-precision field instrument for recording short period components of seismic waves] : Akad. Nauk SSSR Izv. Ser. geofiz., no. 10, p. 1211–1218, 1956.

The MPS–1 seismograph is constructed on the principle of a reactive electromagnetic generator, but using a plunger with a reciprocating axial displacement within the magnetic field instead of the rotating armature. A high magnification of the instrument is achieved by using a very narrow band near the resonant frequency. In combination with a sensitive galvanometer the instrument can have a magnification of as much as 120 decibels, making use of special amplifiers unnecessary. This avoids phase distortion, especially objectionable in the correlation method of seismic surveying.—*S. T. V.*

168–284. Datskevich, A. A. Ispytaniye seysmopriyemnikov [Testing of the geophones] : Prikladnaya geofiz., vypusk 14, p. 47–64, 1956.

A detailed analysis of the complete theory and operation of the geophone. The system ground-geophone-recording channel is considered as a generator of mechanical vibrations, with a known inner resistance and a given velocity, which is loaded with an electromechanical quadripole, characterized by a certain resistance at the entrance and loaded on the exit end by the electric resistance of the recording channel. Formulas are derived for the parameters of every element of the circuit. The procedures for the experimental determinations of different parameters, and the methods of the adjustment of these to any desired set of conditions, are described.—*S. T. V.*

168–285. Lin'kov, E. M. Chetyrekhkanal'nyy elektronnyy ostsillograf dlya zapisi seysmicheskikh kolebaniy [A four-channel electronic oscillograph for recording seismic vibrations] : Leningrad Univ. Uchenyye Zapiski, no. 210, p. 93–99, 1956.

A description of a four-channel oscillograph in which galvanometers are replaced by electronic vacuum tubes. The tubes are free of inertia, consume less current, which is always important in field work, and result in a decrease of the dimensions and weight of the apparatus.—*S. T. V.*

168–286. Lin'kov, E. M. Novyy metod mnogokanal'nogo ostsilligrafirovaniya seysmicheskikh voln [A new method of multichannel oscillographic recording of seismic waves]: Leningrad Univ. Uchenyye Zapiski, no. 210, p. 100–104, 1956.

The method described involves use of electronic tubes instead of galvanometers for oscillographs, multivibrators, and electronic changeover switches. The maximum frequency used was 300 c, although higher frequencies are possible. The feeding voltage of the proposed installation is somewhat higher than in the standard setup. Wiring diagrams are given.—*S. T. V.*

168–287. Denton, Eric M. [R.] Continuous velocity log: Oil and Gas Jour., v. 54, no. 81, p. 224–234, 1956.

Acoustic interval velocity logs have been used primarily to obtain data to be used in conjunction with seismic surveys. However, a velocity log can also be used for identification and correlation of lithologic boundaries between wells and for determination of porosities and detection of hydrocarbons. If a section has a matrix of fairly constant composition and provided that no water-to-hydrocarbon-fluid changes occur, velocity veriations can be interpretated as indicating differences in porosity. If fluid hydrocarbons replace the water in a zone, a decrease in the velocity for this zone will be observed on the log.—*D. R. M.*

168–288. Riznichenko, Yu. V., and Glukhov, V. A. Ob impul 'snom ul 'trazvukovom seysmokarottazhe [On the ultrasonic impulse method of seismic well logging]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 11, p. 1258–1268, 1956.

An ultrasonic combined emitter and receiver of mechanical impulses (see Geophys. Abs. 153–14479) was used in experimental studies in drill holes to obtain the average velocity between the source in the drill hole and a point on the ground near the opening of the hole, and the velocity in individual layers penetrated by the hole. The equipment consists of two transducers: one receiving electric impulses and emitting mechanical strokes on the wall of the hole, and the other receiving the waves propagating along the walls from the strokes and transforming them into electric pulses recorded on an oscillograph. Frequencies ranging from 10^4 to 10^5 cycles per sec were used resulting in high resolving power and making it possible to distinguish layers only 4 to 5 m thick. The method was found to be very efficient and precise, but applicable only in uncased drill holes.—*S. T. V.*

168–289. Dunlap, R. C., Jr. Seismic-magnetic data processing: Oil and Gas Jour., v. 54, no. 76, p. 127–132, 1956.

In seismic-magnetic processing the primary equipment is a recorder that stores information from the shot on a magnetic tape or disk. The record can be replayed through standard as well as special equipment. It is now possible to record the shot with a minimum of predetermined recording techniques, and after the recording is made, variables such as filtering and mixing can be introduced one at a time. Replaying the recording through special equipment removes both

the effects of variations in near-surface conditions and normal moveout of the reflections. The new techniques facilitate the presentation of the seismic record section in either depth or time corrected to a selected datum.—*D. R. M.*

168–290. Waldie, Alan D., Moore, Thomas O., and Jones, Hal T. Magnetic tape recording gains popularity: World Oil, v. 143, no. 7, p. 111–114, 1956.

A review of magnetic tape recording in seismic exploration.—*L. C. P.*

168–291. Vetterlein, Pascal. Die Vorteile von Magnetband-Aufzeichnungen für seismische Messungen [The advantages of magnetic tape recording for seismic measurements]: Erdöl u. Kohle, Jahrg. 9, Heft 11, p. 754–757, 1956.

A review of the technique and advantages of magnetic tape recording in seismic surveys, with illustrations showing the apparatus used by the Prakla Gesellschaft für praktische Lagerstättenforschung.—*D. B. V.*

Hammer, Sigmund I. Modern methods of gravity and seismic interpretation—See Geophys. Abs. 168–143.

168–292. Murusidze, G. Ya. Opredeleniye srednikh shorostey po nagonyayushchim godografam otrashennykh voln [Determination of average velocities from overtaking traveltime curves of reflected waves]: Akad. Nauk Gruzinskoy SSR Soobshcheniya, tom 16, no. 2, p. 103–107, 1955.

The term "overtaking traveltime curves" in Russian seismological literature refers to traveltime curves of profiles in the same direction but from different shot points. The average velocity $\overline{V}$ of seismic waves can be found from two such curves. In the standard equations the value of x_2 in one of the equations is replaced by x_1-d where x are the running coordinates of the curves and d is the distance between shot points. Similarly H_2 can be replaced by $H_1-d \sin \psi$, where H_1 and H_2 are perpendiculars from the shot points to the reflecting plane and ψ is its dip. After some obvious transformations the relation $\overline{V}=[2d \cos 2\psi(\Delta x_1/\Delta y)]^{\frac{1}{2}}$ is obtained. To check the value of ψ, three equations of such traveltime curves can be used. The method has been satisfactorily used since 1950 in several geophysical surveys in the Georgian SSR.—*S. T. V.*

168–293. Scheidegger, A. E., and Wilmore, P. L. The use of a least squares method for the interpretation of data from seismic surveys: Geophysics, v. 22, no. 1, p. 9–22, 1957.

During large-scale seismic surveys it is often impossible to arrange shot points and seismometers in a simple pattern, so that the data cannot be treated as simply as those of small-scale prospecting arrays. It is shown that the problem of reducing seismic observations from m shot points and n seismometers (where there is no simple pattern of arranging these) is equivalent to solving $(m+n)$ normal equations with $(m+n)$ unknowns. These normal equations are linear, the matrix of their coefficients is symmetric. The problem of inverting that matrix is solved here by the calculus of "Cracovians," mathematical entities similar to matrices. When all the shots have been observed at all the seismometers, the solution can even be given generally. Otherwise, a certain amount of computation is necessary. An example is given.—*Authors' abstract*

168–294.—Weber, Max. Die Berechnung der Frontgeschwindigkeit in einem einachsig inhomogenen Körper aus seismischen Refraktionsmessungen [Determination of the wave-front velocity in a uniaxial heterogenous medium from seismic refraction measurements]: Geofisica Pura e Appl., v. 34, p. 1–20, 1956.

Seismic refraction measurements can be directly interpreted by assuming that the inverse function $z=\zeta(c)$ of the wavefront velocity $c(z)$ in horizontal layers can be developed in a power series. The new theory is compared with that of Herglotz-Wiechert and Slichter.—*Author's abstract, M. C. R.*

168–295. Khalevin, N. I. K otsenke tochnosti interpretatsii dannykh metoda prelomlennykh voln [Evaluation of the accuracy of data obtained by the refracted-wave method]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 8, p. 912–919, 1956.

By the refraction method it is possible to determine both the depth of the boundary between two formations and the limiting velocity V_e along the boundary. The average velocity $\overline{V}$ in the upper formation must be known and in addition to depth and V_e, ψ, the angle of dip, is also determined.

The magnitude of the errors in dip, depth, and limiting velocity is analyzed in relation to the error in $\overline{V}$. The accuracy of the depth is affected by the ration $\overline{V}/V_e$ and decreases very rapidly as $\overline{V}/V$ approaches 1. The error in depth is also affected by the error in the assumed value of V_e; when $\overline{V}/V_e$ is 0.9 the error due to the inaccuracy of V_e is almost equal to that due to error in $\overline{V}$. Similarly, the dip error becomes inadmissibly high when $\overline{V}/V_e$ approaches 1. Results are illustrated by several sets of graphs.—*S. T. V.*

168–296. Pakiser, L. C., and Black, R. A. Exploring for ancient channels with the refraction seismograph: Geophysics, v. 22, no. 1, p. 32–47, 1957.

In the Monument Valley of Arizona and Utah, uranium ore has been found in ancient channel deposits, primarily in the Shinarump member of the Chinle formation of Late Triassic age. The seismic velocity in the Shinarump member is substantially less than that in the Moenkopi formation of Early and Middle(?) Triassic age, which unconformably underlies the Shinarump. Therefore, the ancient channels can be located by using the refraction seismograph. Because the erosion surface of the Moenkopi in channel areas is curved a delay-time method of analysis is used to determine the position in depth of the Shinarump and Moenkopi contact. The problem of velocity variations within the Shinarump can be largely overcome by careful interpretation supported by drill-hole and velocity control.—*Authors' abstract*

168–297. Peter, Philip W., and Martin, Richard G. Possible application of the reflection seismograph in determining structural controls favorable for uranium deposition: Mines Mag., v. 46, no. 10, p. 31–32, 1956.

Anticlines, synclines, homoclines, structural terraces, and faults, and their related joint systems, exert an important control on uranium deposition. Many of these structures can be found by using the reflection seismograph.—*L. C. P.*

Glangeaud, Louis; Pézard, Robert; François, Solange; Perrenoud, Marie-Jean; and Toitot, Michel. The phreatic and artesian ground waters of the northern Jura, Doubs.—See Geophys. Abs. 168–99.

168–298. Helbig, Klaus. Bemerkungen zum Spektrum seismischer Schüsse unter Tage [Remarks on the spectrum of seismic shooting underground] : Geol. Jahrb., Band 71, p. 671–674, 1956.

The first underground seismic shooting in the Siegerland siderite mines in Germany showed that a different frequency range is involved than that in surface surveys. The energy falls chiefly in the range of 200–400 cycles per sec, with a maximum of 500 and minimum of 150 cycles per sec, but with no discrete frequencies. The upper limit is unexpectedly low. A double impulse was registered unfiltered and with three different filters (80–100, 75–150, and 150–300 cycles per sec) ; a clear separation of the two impulses was obtained only with the third.—*D. B. V.*

168–299. Berzon, I. S. Effektivnyye skorosti i glubiny opredelyayemyye po godografam mnogokratno otrazhennykh voln [Effective velocities and depths determined by the traveltime curves of multiple reflections] : Akad. Nauk SSSR Izv. Ser. geofiz., no. 8, p. 881–895, 1956.

Criteria for the identification of multiple reflections have been determined for the cases where the velocity varies continuously with depth. Four possible cases of double reflection are analyzed on the basis of the kinematic properties of individual waves. Effective velocities of the individual waves are determined by comparison of the traveltime curves. Such an analysis is useful in only a few cases for often the interference between the singly and doubly reflected waves makes their separation impossible. More success is expected from analysis of the dynamic properties of such waves.—*S. T. V.*

168–300. Bortfeld, Reinhard. Multiple Reflexionen in Nordwestdeutschland [Multiple reflections in northwest Germany] : Geophys. Prosp., v. 4, no. 4, p. 394–423, 1956.

Many multiple reflections in northwest Germany can be recognized in routine Δt analysis because of the great contrast in the interval velocities in Tertiary and Upper Cretaceous formations. Multiple reflections caused by reflections at two different reflectors and the surface are theoretically the most probable and the most often observed.—*M. C. R.*

168–301. Breyer, Friedrich. Ergebnisse seismischer Messungen auf der süddeutschen Grossscholle besonders im Hinblick die Oberfläche des Varistikums [Results of seismic measurements on the south German major fault block especially in regard to the surface of the Variscan] : Deutsch. Geol. Gesell. Zeitschr., Band 108, Teil 1, p. 21–36, 1956.

The subsurface geology of southern Germany, particularly the surface of the Variscan basement ("Vindelizic Land"), is deduced from seismic data compiled from various published and unpublished sources (quarry explosions at Lengfurt, Saal, Blaubeuren, and Erlenbach ; refraction profiles in Nürtingen, Mittelfranken, Kraichgau, Göppingen-Nürtingen, and the Nördlinger Ries) and from 32 deep borings. Sketch maps show contours on the Variscan for the whole and parts of the area ; other data are illustrated by sections of profiles and tables of velocities and borehole data.—*D. B. V.*

168–302. Hecht, F., Helms. H[ans] v[on], and Kehrer, W[ilhelm]. Reflection-seismic exploration of Schleswig-Holstein, Germany, and its geological interpretation by well data [with discussion] : World Petroleum Cong., 4th sess., Rome, Proc., sec. 1, p. 715–730, 1955.

Detailed reflection surveys in all of Schleswig-Holstein have resulted in an accurate delineation of geological structures. The exact stratigraphic position of typical seismic horizons was known from well data, and certain horizons could be traced regionally because of their uniform velocities. In addition to the salt domes, structural and stratigraphic traps have been found in the Wealden and Dogger. The main structural units in Schleswig-Holstein are the West Schleswig and East Holstein blocks, smooth uplifts with structurally high-lying Triassic and the Middle Holstein block consisting of the deep Heide and Bramstedt-Kiel Jurassic troughs separated by the Rendsburg uplift. So far, all discoveries have been confined to the Jurassic troughs and borders of late Tertiary depressions, with new production all from the Wealden and Dogger.—*D. B. V.*

168–303. Kokesh, Frank P. Gulf Coast seismic velocity surveys: Mines Mag., v. 46, no. 11, p. 55–58, 1956.

A discussion of seismic velocity surveys in the gulf coast area of the United States, with emphasis on recent use of the long-interval method of measuring velocity in deep drill holes.—*L. C. P.*

STRENGTH AND PLASTICITY

168–304. Paterson, M. S. Lüders' bands and plastic deformation in the earth's crust: Geol. Soc. America Bull., v. 68, no. 1, p. 129–130. 1957.

In mild steel and certain other materials, the distribution of plastic strain after yielding under a uniform stress is nonuniform. The stress needed to continue plastic straining is lower than that needed to start it so plastic deformation is concentrated at first in those zones (Lüders' bands) in which it began and continues until local strain hardening raises the yield stress beyond the applied stress so that yielding occurs in previously undeformed zones. Menard has compared the "fracture zones" in the northeastern Pacific basin to Lüders' bands. If these are Lüders' bands, the crustal material has the property that when yielding begins at any given place the local yield stress falls immediately, and also the regions between the fracture zones cannot yet have undergone plastic deformation.—*M. C. R.*

168–305. Griggs, D. T., and Kennedy, G. C. A simple apparatus for high pressures and temperatures: Am. Jour. Sci., v. 254, no. 12, p. 722–735, 1956.

A simple apparatus, based on the principle of Bridgman's shearing apparatus, provides pressures of 80 kilobars at 500° C, 50 kb at 800° C, and 20 kb at 1,000° C. Pressure is known within approximately 5 percent, and temperature at 5° C. The sample in powdered form, is compressed between two pistons which are externally heated and pressed together by a hydraulic jack. Under certain circumstances water vapor pressure in the sample may equal total pressure, even at high temperatures. The apparatus is extremely easy to use, and equilibrium seems to be attained more rapidly than in the case of pure hydrostatic pressure. Thus it seems well adapted for study of metamorphic reactions within the range of pressure and temperature to be expected normally in the outer 50–100 kilometers of the Earth.—*Author's abstract*

168–306. Balkay, Bálint. Új kőzetfizikai kísérletek [Recent experiments on physical properties of rocks]: Földtani Közlöny, kötet 86, füzet 3, p. 284–286, 1956.

Recent experiments on the behavior of rocks at high pressures and temperatures and in the presence of different solutions show that the deformation of rocks composed of minerals with well-developed gliding planes (halite, gypsum, limestone, dolomite, ice) is intermediate between that of ductile metals and rigid materials, such as silicate rocks. In the latter, deformation takes place partly by crystalloblastic processes and partly by annealing recrystallization of fractured crystals.—*D. B. V.*

VOLCANOLOGY

168–307. Matschinski, Matthias. Composition chimiques des roches et caracteristiques des arcs volcaniques [Chemical composition of rocks and characteristics of volcanic arcs]: Soc. géol. France Compes Rendus, no. 13, p. 242–244, 1956.

Data representing 2,500 chemical analyses of 255 rocks from 179 volcanoes in 15 volcanic arcs are tabulated to show the correlation between chemical composition and physical characteristics (radius of curvature, "density") of volcanic arcs. The results are regarded as a first approximation but are probably not far from reality. (See also Geophys. Abs. 148–13395, 13396, 154–14743, 167–276.)—*D. B. V.*

168–308. Powers, Howard A. Activity of Alaskan volcanoes, 1949–1953: Pacific Sci. Assoc., 8th Cong., Proc., v. 2, p. 21–22, 1953 (1956).

During the period 1949–53, 11 volcanoes of the Alaska-Aleutian chain were constantly steaming and sporadically erupting puffs of gases and ash. In 1950 Novarupta built a small cone adjacent to the main mass formed in the 1921 activity; at Trident, inactive during historic time, an explosive ash eruption in February 1953 was followed by slow extrusion of viscous lava; Mount Spurr, also quiet during historic time, explosively erupted juvenile ash and coarser pyroclastic material in July 1953.—*D. B. V.*

168–309. Taylor, G. A. Report on volcanology: Australia: Pacific Sci. Assoc., 8th Cong., Proc., v. 2, p. 30–32, 1953 (1956).

The most severe eruptions during the period 1949–53 were those of Ambrym in the New Hebrides, which began in December 1950 and resumed, after 8–9 months of quiescence, in August 1952; the explosive activity at Mount Bagana in New Guinea, in 1950 and 1952; and at Mount Lamington in New Guinea. The last had not been recognized as active and peléan explosions from January to June 1951 were disastrous. A volcanological station was maintained for 2 years at Mount Lamington after the initial eruption. The observatory at Rabaul was being reestablished.—*D. B. V.*

168–310. Meyer-Abich, Helmut. Los volcanes activos de Guatemala y El Salvador (America Central) [The active volcanoes of Guatemala and Salvador (Central America)]: Servicio geol. nac. El Salvador Anales, Bol. no. 3, 102 p., 1956.

A description of 12 active volcanoes in Guatemala and 13 in El Salvador. For each, the location, altitude, form and structure, extent of activity, and petrog-

raphy of lavas are noted, and numerous photographs, sketch maps and diagrams of the most important are included. The term "active volcano" as used here includes those which show fumarolic or solfataric activity and some independent fumarole and solfatara fields. An extensive bibliography.—*D. B. V.*

168–311. Macdonald, Gordon A. Hawaiian volcanoes from 1949 to 1952: Pacific Sci. Assoc., 8th Cong., Proc., v. 2, p. 11–20, 1953 (1956).

In the eruption of Mauna Loa from January 6 to June 1, 1949, about 59 million cubic m of lava, two-thirds of which were emitted in the first 24 hours, covered 14.5 km^2. Another eruption of Mauna Loa took place from June 1 to 23, 1950, liberating 460 million cubic m of lava over an area of 90.4 km^2. At Kilauea, subterranean magma movement was indicated during December 1950 by earthquakes and ground tilt. Usually large earthquake activity during 1951 and 1952 indicated uneasiness in both Kilauea and Mauna Loa. Kilauea erupted, after a repose of nearly 18 yrs, from June 27 to November 19, 1952; Halemaumau crater became filled with approximately 49 million cubic m of new lava which raised its floor about 125 m.—*D. B. V.*

168–312. Macdonald, Gordon A. Hawaiian volcanoes during 1952: U. S. Geol. Survey Bull. 1021–B, 108 p., 1955.

The outstanding event in the Hawaiian Islands for 1952 was the eruption of Kilauea for the first time in 18 years. Activity started in March and April with a swarm of more than 4,000 earthquakes centered along a line parallel to the southern shore of the island of Hawaii and 10 to 15 miles offshore. In April a series of earthquakes occurred along the east rift zone and beneath the caldera region of Kilauea, accompanied by northward tilting of the ground at the northeast edge of the caldera. The volcano erupted on June 27, 1952, along a fissure in a northeast-southwest direction across the floor of Halemaumau, and activity continued until November 10. The average depth of the new lava fill was 310 feet, the volume of new lava was 64,000,000 cubic yards, and the depth of the crater had decreased from about 770 feet, before the eruption, to 460 feet. The rise of the crater floor was caused partly by overflow of new lava and partly by bodily elevation as new lava was squeezed into the still-mobile lower part of the new fill.—*V. S. N.*

168–313. Die Umschau. Ausbruch des Stromboli [Eruption of Stromboli]: Umschau, Jahrg. 56, Heft 21, p. 650–651, 1956.

Stromboli is the only volcano in the world that is active regularly. The throat of the volcano, about 400 m in diameter, is 100 m below the summit; there are 2 craters characterized by entirely different kinds of activity. The main crater, a funnel-shaped opening, is continuously active; in it, red molten lava can be distinguished at night in 5 distinct vents. At irregular intervals this crater erupts lava to heights of as much as 200 m. The second crater, presumably connected with the first, becomes explosively active only when pressures build up too high to be relieved in the first; this happens at regular intervals of 16 to 20 minutes when glowing lava and ashes are thrown several hundreds of meters into the air. These outbreaks usually last 20 to 40 seconds but may continue for as long as 2 minutes; lava streams may flow over the "Sciara del Fuoco" into the sea. Sudden drops in atmospheric pressure bring on sharp increases in activity. The submarine eruptions around the foot of the mountain in the past year were probably connected underground with the main crater.—*D. B. V.*

168–314. Minakami, T[akeshi]. Report on volcanology: Japan: Pacific Sci. Assoc., 8th Cong., Proc., v. 2, p. 35–43, 1953 (1956).

A list of the activity of Japanese volcanoes for the period 1949–53, most important of which were the vulcanian eruptions of Asama-yama in 1949 and 1950; the combined hawaiian-strombolian types of Mihara-yama, July–September 1950 and February–June 1951; and the submarine eruption of Myojin Reef in September 1952.— *D. B. V.*

168–315. Minakami, Takeshi, and Morimoto, Ryōhei. Volcanic activities in Japan during the years 1949–1953; Pacific Sci. Assoc., 8th Cong., Proc., v. 2, p. 241–251, 1953 (1956).

During 1949–53 activity was reported from nine Jananese volcanoes. The 1950–51 eruption of Ōshima and the submarine eruption of Myojin were the most important. The others were Akita-yakeyama, Kurikoma, Azuma, Yakeyama, Asama, Aso, and Sakurajima. Volcanic tremors accompanying the strombolian eruption of Ōshima consisted of a group with shorter periods (0.2–0.4 sec) and smaller amplitudes, which originated several hundred meters below the active crater (Mount Mihara), and a group, with varying periods (ranging from 0.2 to 0.9 sec) and larger amplitudes, which originated near the head of the fresh lava column in the active vent.

The submarine eruption of Myojin reef began in September 1952, at the site of an ephemeral island formed in February 1946. A new island, 100 by 150 m and 100 m high, was built, but it disappeared within a few days. Activity continued as intermittent submarine eruptions which hurled domes of water 20 m or more into the air, then ejected bombs in a manner similar to that observed during the formation of Anak Krakatau. Energy of one of the explosions was estimated as about 10^{18} ergs. The dome was reported to have reappeared above sea level in October 1952.—*D. B. V.*

168–316. Piyp, B. I. Sostoyaniye deystvuyushchikh vulkanov severnoy Kamchatki v 1954 g. [The state of active volcanoes of northern Kamchatka in the year 1954]: Akad. Nauk SSSR Lab. vulkanol., Byull. vulkanol. stantsii, no. 24, p. 14–20, 1956.

Results of volcanologic observations during January to August 1954 on the four most important volcanoes of northern Kamchatka: Klyuchevskaya Sopka, Sheveluch, Tolbachik, and Kizimen. The first three are active. The eruption of the Klyuchevskaya Sopka was accompanied by local earthquakes. Intense fumarolic activity was observed at all four; analyses of gases, their temperature, and location of the fumaroles are given.—*S. T. V.*

168–317. Basharina, L. A. Fumaroly vulkana Sheveluch v sentyabre-dekabre 1953 g [The fumaroles of Sheveluch volcano during September-December 1953]: Akad. Nauk SSSR Lab. vulkanol., Byull. vulkanol. stantsii, no. 24, p. 21–27, 1956.

The chemical composition of the gases and of the thermal springs, their temperature, and other properties of the fumaroles on the slopes of the Sheveluch volcano, Kamchatka, were studied during the months of September–December 1953. The highest temperature found was about 295° C. The fumaroles contained CO_2, HCl, SO_2, HF, H_2SO_4, HBr, H_3BO_3 and other gases in smaller amounts.—*S. T. V.*

168–318. Sirin, A. N., and Timerbayeva, K. M. Karymshchinskiye goryachiye klyuchi [The hot springs of the Karymshchina Valley] : Akad. Nauk SSSR Lab. vulkanol., Byull. vulkanol. stantsii, no. 24, p. 47–51, 1956.

A description of the geology and the hot springs of the valley of the Karymshchina River, Kamchatka. The springs emanate from numerous fissures trending northwest and northeast. These two directions are frequently observed in the geologic structure of Kamchatka and are evidently caused by deep tectonic fractures predominant in this region.—*S. T. V.*

168–319. Svyatlovskiy, A. Ye. Dva svoyeobraznykh vulkana Tolmacheva Dola [Two peculiar volcanoes of the Tolmachev Dol] : Akad. Nauk SSSR Lab. vulkanol., Byull. vulkanol. stantsii, no. 24, p. 52–60, 1956.

The Tolmachev Dol is a large highland formed by lava from several volcanoes of the Kamchatka Peninsula. This highland is studded with craters of numerous volcanoes, some of which are still active. A detailed description of the two largest is given, with special attention to the chronological sequence of the genesis of the craters on the Tolmachev Dol.—*S. T. V.*

168–320. Korsunskaya, G. V. Vulkany ostrova Simushir [Volcanoes of Simushir Island] : Akad. Nauk SSSR Lab. vulkanol., Byull. vulkanol. stantsii, no. 24, p. 61–64, 1956.

A description of Simushir Island which like many islands in the Kurile arc is composed of two active and several extinct volcanoes resting on a huge submarine ridge. Analyses of the lava and tuffs of the different volcanoes are included. The last violent eruption of the Goryashchaya Sopka (the burning volcano) occurred in 1914.—*S. T. V.*

168–321. Gonzalez-Reyna, Jenaro. A new volcano: Pacific Sci. Assoc., 8th Cong., Proc., v. 2, p. 25, 1953 (1956).

A submarine eruption of short duration was noted on July 20, 1953, 12 km off the island of San Cristobal near the coast of Lower California.—*D. B. V.*

168–322. Foshag, William F. Parícutin: Pacific Sci. Assoc., 8th Cong., Proc. v. 2, p. 24–25, 1953 (1956).

Parícutin ceased activity on March 4, 1952, as suddenly as it began. During 1949–52 the principal lava vent was above the site of the buried cone Zapichu. The average height of the cone above the original vent was 378 m at the end of 1951.—*D. B. V.*

168–323. Richards, Adrian F., and Dietz, Robert S. Eruption of Bárcena volcano, San Benedicto Is., Mexico: Pacific Sci. Assoc., 8th Cong., Proc., v. 2, p. 157–176, 1953 (1956).

The first pumice eruption in historic time in the eastern Pacific Ocean basin occurred on August 1, 1952, when a new volcano, Bárcena (originally called Boquerón) was born on San Benedicto Island off the west coast of Mexico. Twenty minutes after the first wisp of steam appeared, witnessed by a fishing boat, a column of dark steam and ash had ascended to more than 7,000 ft and nearly obscured the island. Seen from the air on August 12, the cone was about 1,200 ft high and showed strong evidence of glowing cloud eruptions. By September 20 activity had quieted and the throat was plugged with congealed lava. On November 13 activity was resumed; and on December 8 lava began to flow

viscously from a fissure at the eastern base and built a "delta" which ultimately measured 1,400 ft in width and extended 700 yds seaward. Activity decreased after December 12 and on February 27 only fumarolic activity was seen. The four islands of the Revillagigedo group, of which San Benedicto is one, lie on a major fracture zone of the earth's crust. Volcanism seems to have progressed eastward as in the Hawaiian Islands.—*D. B. V.*

168–324. Best, J. G. Investigations of recent volcanic activity in the Territory of New Guinea: Pacific Sci. Assoc., 8th Cong., Proc., v. 2, p. 180–204, 1953 (1956).

Increased activity of Mount Langila, New Britain, was noted about April 1952. In the northern crater three large fumaroles and numerous minor vents emitted high pressure vapor charged with acid gases at high temperature. A tiltmeter showed a maximum rise of 8 minutes during a period of several days, later correlated with increased tectonic earth tremor frequency recorded at Umboi Island. Long Island, in the New Britain group, became explosively active in May–June 1953, and a new cone was formed within the caldera lake. In the Admiralty Group, a submarine eruption occurred in St. Andrew Strait from June 27 until July 6, 1953. Premonitory seismic activity was too minor to be felt in the surrounding islands. Minor tremors which correlated with explosions at the vent were noted during the eruption. The vapor emitted was mostly steam with traces of SO_2; ash and lapilli and other ejecta were thrown hundreds of feet into the air. The activity is considered to be a reactivation of a minor vent within the caldera formed by Lou and the Pam islands. Manam Island, off the northwest coast of New Guinea, showed signs of increased activity in 1952–53.—*D. B. V.*

168–325. Taylor, G. A. An outline of Mount Lamington eruption phenomena: Pacific Sci. Assoc., 8th Cong., Proc., v. 2, p. 83–88, 1953 (1956).

The catastrophic glowing cloud eruption of Mount Lamington in northern Papua, on January 21, 1951, was presaged by landslides around the summit area several weeks before, and by earth tremors and emission of increasing amounts of smoke and gas in the days immediately preceding the eruption. After the two major paroxysms on the first day, there was a lull, followed by intermittent explosions beginning on the fourth day, and uplift of a lava dome beginning on February 3. By February 10 the dome had risen more than a thousand feet above the crater floor. On March 5 a major eruption partially destroyed the dome, and lava poured down the northern slopes retaining its mobility for 9 miles. After this, explosive activity predominated. On January 26, 1952, the dome reached its maximum height of 1,900 ft. Activity declined during the last 6 months of 1952. The relation between seismic phenomena and explosive activity was unusually close. Secondary seismic activity was associated with the growth of the lava dome.—*D. B. V.*

168–326. Healy, J. Report on volcanology: New Zealand: Pacific Sci. Assoc., 8th Cong., Proc., v. 2, p. 27–30, 1953 (1956).

The first historic lava flow in New Zealand occurred during the eruption of Ngauruhoe that began in February 1949. The volcano erupted again between November 1952 and July 1953. At Ruapehu minor ash eruptions were noted in June 1950 and March 1951. White Island remained in the solfataric stage. Geophysical observations planned at Tongariro National Park included installation

of seismic equipment, a recording magnetometer, and earth-current apparatus. A gravity survey of part of the park area was in progress.

The Wairakei thermal area was being investigated for development of geothermal power by detailed geological, gravity, magnetic, and seismic surveys and geochemical and geothermal investigations. Geophysical surveys were also made at Te Teko in the Bay of Plenty and in the Waiotapu area. The gravity survey was being extended over the volcanic region, and an aeromagnetic survey of the entire volcanic region was made from an altitude of 5,000 ft above sea level.—*D. B. V.*

Baumgart, I. L., and Healy, J. Recent volcanicity at Taupo, New Zealand.—See Geophys. Abs. 168–5.

168–327. Healy, J. Preliminary account of hydrothermal conditions at Wairakei, New Zealand: Pacific Sci. Assoc., 8th Cong., Proc., v. 2, p. 214–227, 1953 (1956).

Geothermal investigations at Wairakei, New Zealand, have shown that saturated steam is present to a depth of at least 2,200 ft. Total heat flow has been estimated as about 130,000 cal per sec, half of which is discharged in steam at the boiling point and the rest in hot water. The minimum mass discharge of steam and hot water is 960 kg per sec, but the actual amount is probably twice that and more than twice the annual rainfall of the area. Magmatic steam from a large igneous body at great depth is probably the source of the heat.—*D. B. V.*

168–328. de Swardt, A. M. J. The 1954 eruption of Cameroon Mountain: Geol. Survey Nigeria Rec. 1954, p. 35–40, 1956.

The eruptions of Cameroon Mountain in July 1954, the third about which information is available, were of the vulcanian type. All geologically recent eruptions in the area seem to have been typically strombolian or even hawaiian. Two strong shocks preceded the 3-week series of eruptions. From the appearance of the bottom of the crater it is concluded that the feeding channel was not open during the eruptions and that each discharge worked its way through a plug of loose debris. The pattern of eruption suggests that gases ascended in separate pockets. Sufurous or acid fumes were absent. A possible cause of the outbreaks may have been the seeping down of ground water through the porous mass to a central plug of solid but still very hot lava.—*B. T. E.*

168–329. Spann, Hans. El volcan Ubinas [The volcano Ubinas]: Pacific Sci. Assoc., 8th Cong., Proc., v. 2, p. 56–59, 1953 (1956).

A description of the volcano Ubinas, in the province General Sanchez Cerro, Peru. The only known and recorded eruption occurred in 1662. The continual emission of gases and sulfurous vapors, together with subterranean noises, suggests that Ubinas is not extinct but merely in a period of quiescence.—*D. B. V.*

168–330. Alcaraz, Arturo. Report on volcanology: Philippines: Pacific Sci. Assoc., 8th Cong., Proc., v. 2, p. 32–34, 1953 (1956).

Hibok-Hibok on Camiguin Island began erupting in August 1948 and erupted more or less continuously during 1949–53. A cycle of activity with a period of 9 to 14 months was noted: a short period of emission of smoke from the

crater; explosions with emission of heavy clouds of steam, ash, and other ejecta; disgorging of incandescent material, much ash and smoke, agglomeratic flows, and occasional minor crateral outbursts; decrease in amount of smoke and ejecta. Paroxysmal phases occurred in September 1948, June 1949, September 1950, December 1951 (taking 500 lives and causing extensive damage), and October 1952.

Didicas erupted in March 1952 after 96 years of quiescence. After a year of activity the original Didicas Rocks had been completely covered by a cone 830 ft high and about 3,650 ft at the base. Activity was vulcanian, with emission of large amounts of steam and sulfurous gases and quiet extrusion of andesitic aa lava. Taal volcano, quiet since 1911, showed limited solfataric activity on the shore of its crater lake.—*D. B. V.*

168–331. Alcaraz, Arturo, Abad, Leopoldo F., and Tupas, Mateo H. The Didicas submarine volcano: Pacific Sci. Assoc., 8th Cong., Proc., v. 2, p. 139–156, 1953 (1956).

On March 16, 1952, a column of smoke was observed coming in bursts from the sea at Didicas Rocks, a group of three separate masses off the coast of Luzon. An earthquake centering in the vicinity on March 2 was probably a concomitant of the start of the activity or may have preceded it by a few days. Observations from the air on March 19 showed a cone of blocky lava about 250 ft high already covering two of the three Didicas Rocks and a column of ash and smoke reaching a height of several thousand feet. When a field party reached the site on March 30, the dome was 480 ft above sea level and about 1,900 ft in diameter at the base. Assuming that the top of the dome was about 60 ft below the surface when first reported, it must have grown at a rate of 40 ft per day, representing the extrusion of half a billion cubic feet of material in 14 days. Observations from the air on June 17 showed that activity had subsided to a great extent; the dome was then about 750 ft high, 3,000 ft by 4,500 ft at the base. On August 23 appreciable "smoke" was still being erupted, and the dome had grown to approximately 800 ft and covered the last of the original rocks.—*D. B. V.*

168–332. Pelaez, Vinicio R. The volcanic activity of Catamaran and Hibok-Hibok, Camiguin Island, Mindanao, of September 1948: Pacific Sci. Assoc., 8th Cong., Proc., v. 2, p. 89–112, 1953 (1956).

Activity on Camiguin Island in the Philippines began with a strong earthquake on August 31, 1948. On September 1, tremors and landslides occurred at the summit crater of Catamaran. Later the same day a violent explosion, accompanied by a strong earthquake, rocked the island and disrupted the pyroclastic materials sealing both the main crater and the solfataric flank crater at Hibok-Hibok. Breaching of the crater wall at Hibok-Hibok caused a heavy landslide at the time of the explosion. Ash and gases emitted were so hot that from September 4 to September 8 the wall of Hibok-Hibok crater glowed incandescently. On September 9 a second landslide plugged the side crater, which thereafter showed only fumarolic activity.—*D. B. V.*

168–333. Alvir, A. D. A cluster of little known Philippine volcanoes: Pacific Sci. Assoc., 8th Cong., Proc., v. 2, p. 205–208, 1953 (1956).

A brief description of a cluster of solfataric volcanoes in the subprovince of Kalinga, Mountain Province, Luzon. In the crater of Ambalatungan, a

number of hot gas vents are depositing sulfur in towerlike structures a few meters high; hot springs abound. Bumabag, 3 km to the east, consists of two craters with activity similar to that of Ambalatungan. Podokan, the last of the group, lies about 1 km southeast of Bumabag and has a spectacular steam vent.—*D. B. V.*

162–334. Barrabé, Louis. L'éruption de la Soufrière de la Guadeloupe [The eruption of Sourfrière de la Guadeloupe] : Soc. géol. France Comptes Rendus, no. 13, p. 233–234, 1956.

On the night of October 19–20, 1956, ash erupted without noise from the Soufrière volcano, on the island of Guadeloupe; in the morning the ash cloud was more than 500 m high. Activity ceased on October 21 and resumed on October 24 with emission of a large amount of ash in a short time. Since then, activity has been very feeble. Only very weak volcanic tremors were recorded, before and during the eruption. A similar eruption in 1836 lasted about 3 weeks.—*D. B. V.*

168–335. Barrabé, Louis. L'évolution de l'éruption de la Soufrière de la Guadeloupe [The evolution of the eruption of Soufrière de la Guadeloupe] : Soc. géol. France Comptes Rendus, no. 16, p. 305–306, 1956.

A further note on the eruption of the Soufrière on the island of Guadeloupe which began on October 19, 1956. External manifestations ceased after October 24. The only indications of the approaching eruption were an increase in temperature of fumaroles for some months previous and the appearance of new fumaroles where none had existed for many years. Very weak near earthquakes were recorded at the observatory in September and again in early December. The eruption opened a large new fissure in the cone, extending midway down the slope southeastward from the center of the plateau, with a second shorter fissure, west of the first in the southern part of the plateau. Two old inactive pits in the center of the plateau now emit steam with SO_2 and H_2S. (See also preceding abstract.)—*D. B. V.*

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